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52D CONGRESS, 2d Session. } HOUSE OF REPRESENTATIVES. { EX. DOC. 1, Part 2.

REPORT

OF THE

SECRETARY OF WAR;

BEING PART OF

THE MESSAGE AND DOCUMENTS

COMMUNICATED TO THE

TWO HOUSES OF CONGRESS

AT THE

BEGINNING OF THE SECOND SESSION OF THE FIFTY-SECOND CONGRESS.

IN FOUR VOLUMES.

VOLUME III.

WASHINGTON:
GOVERNMENT PRINTING OFFICE.
1892.

REPORT OF THE CHIEF OF ORDNANCE.

WAR DEPARTMENT, ORDNANCE OFFICE,
Washington, October 1, 1892.

SIR: I have the honor to submit the following report of the principal operations of the Ordnance Department during the fiscal year ended June 30, 1892, with such remarks and recommendations as the interests of this branch of the military service seem to require.

The fiscal resources and expenditures of the Department during the year were as follows, viz:

Amount in the Treasury to the credit of the appropriations on June 30, 1891	$7,434,491.28
Amount in the Treasury not reported to the credit of the appropriations on June 30, 1891	662.24
Amount in Government depositories to the credit of disbursing officers and others on June 30, 1891	540,378.99
Amount of appropriations for the service of the fiscal year ended June 30, 1892	1,240,887.79
Amounts refunded to ordnance appropriations in settling accounts during the fiscal year ended June 30, 1892	197,991.19
Gross amount received during the fiscal year ended June 30, 1892, from sales to officers; from rents; from collections from troops on account of losses of or damage to ordnance stores; from Chicago, Rock Island and Pacific Railroad Company; from powder and projectiles (proceeds of sales); from sales of condemned stores; from testing machine, and from all other sources not before mentioned..	90,267.69
Total	9,504,679.18
Amount of expenditures during the fiscal year ended June 30, 1892, including expenses attending sales of condemned stores, exchange of powder, etc	$3,908,907.81
Amount deposited in Treasury during the fiscal year ended June 30, 1892, as proceeds of sales of Government property	64,882.06
Amount turned into the surplus fund on June 30, 1892	7,804.84
Amount in Government depositories to the credit of disbursing officers and others on June 30, 1892	532,296.47
Amount transferred from ordnance appropriations in settling accounts during the fiscal year ended June 30, 1892	1,109.33
Amount in the Treasury not reported to the credit of appropriations on June 30, 1892	817.87
Amount in the Treasury to the credit of appropriations on June 30, 1892	4,988,860.80
Total	9,504,679.18

CLERICAL FORCE.

It is necessary that your attention should again be invited to the inadequate clerical force in this office. This has been reported in previous annual reports, and the Secretary of War has directed that an estimate be submitted to Congress for a sufficient clerical force. This was done in my estimates of last year, but the necessary appropriation was not obtained. The estimate is again included in my estimates of this year. Five additional clerks are necessary. Careful efforts have been made to reduce to a minimum the clerical work that must be performed, but in spite of this the largely increased business of the Department, due to the large appropriations for, and gun construction for, coast defense and labor required, under the act of February 12, 1887, for arming and equipping the militia, has increased the necessary clerical labor each year. There is now a large arrear of clerical labor, which the interests of the service demand should be brought up to date. With the present force this is impossible, and, on the contrary, it is impossible to perform properly the current work of each year.

Four clerks were withdrawn from this office when the Record and Pension Division of the War Department was organized. The five clerks asked for are to provide for replacing these and to give one additional clerk.

THE DISTRICT OF COLUMBIA MILITIA.

My annual estimates of this year contain an item for arming and equipping the militia of the District of Columbia. The following remarks on this subject are copied from my annual report of last year:

> The act of March 1, 1889 (vol. 25, p. 77, 2 Stat. L.), to provide for the organization of the militia of the District of Columbia, provides (section 31) that the ordnance and ordnance stores necessary to arm, equip, and instruct said militia shall be issued from the stores and supplies provided for the use of the regular Army; but the act failed to make any appropriation to enable the Ordnance Department to make good the depletion of the limited army supplies by these issues to the militia.
>
> As the property issued as provided for in this act must be taken from the supplies for the Army—that is, from the appropriations for these supplies—and as it is a fact that the appropriations now made are insufficient for the actual needs of the Army, it is evident that if the militia is supplied the Army will suffer, and *vice versa*.
>
> The issues thus far made under this act amount to $43,793.21, and an item of this amount is embraced in the estimates to be laid before Congress. In my judgment it would be wise to have a permanent appropriation of a fixed amount for each year to provide for these issues to the District militia, or a specific appropriation for each year.

The importance of maintaining the efficiency of the District militia need not be stated. The small allotment due to the District from the general appropriation for arming and equipping the militia of the United States is inadequate for this purpose.

APPROPRIATION FOR ARMING AND EQUIPPING THE MILITIA OF THE UNITED STATES.

Your attention is urgently invited to the inadequacy of the general appropriation for arming and equipping the militia. Under the act of 1808 this appropriation was $200,000 per annum for the militia of all the States. The highly improved arms, equipments, and artillery of the present day cost for the same number of men more than treble the cost of the same eighty-four years ago, when the above act was passed. The population of the country is now more than ten times that of 1808, and the demand for these equipments has increased more than ten times. The act of February 12, 1887, increased this appropriation, but made it include also camp and garrison equipage and clothing furnished by the Quartermaster's Department. This act, instead of increasing the appropriation for arming and equipping the militia (that is, the portion used for arms and equipments), as was intended by Congress, actually resulted in a reduction of this portion of the appropriation last year to $173,000.

The above figures should show how inadequate the present appropriation must be. Experience proves that it is so. The small allotment which can be made to each State from the appropriation is carefully husbanded and economically used, but is insufficient. The War Department is then constantly troubled by urgent requests from the States for larger supplies than can be furnished under the allotments. The urgent importance of maintaining not only the present force and efficiency of the States' militia, but of greatly enlarging the same, is admitted and urged by the War Department. It is a hardship, then, for the Department to be constantly compelled to refuse the most needful supplies. The inability to furnish these supplies not only cripples the efficiency of the present militia force and dampens the valuable ardor of officers who are engaged in promoting its efficiency, but makes a further enlargement of the militia force, which is so highly necessary, practically impossible. It is hoped that if this matter is properly urged upon the attention of Congress a more suitable appropriation for the armament and equipment of the militia may be made.

In this connection I again invite your attention to a communication sent to you on March 21, 1892:

I have the honor to invite your attention to certain objections to existing laws in regard to the disposition to be made of obsolete and unserviceable arms, equipments, etc., turned in to this Department by the militia, with the view, should you approve of the same, of requesting action from Congress to correct the same.

The law now provides that such obsolete and unserviceable arms and equipments shall be sold and the proceeds of such sales covered into the Treasury. This law is made uniform with the law in regard to the disposition of the same material when turned in by the regular Army.

In the latter case—that is, in regard to material turned in by the Army—the law is a good one and should not be changed, because in this latter case the War Department goes before Congress each year, explains its necessity in estimates, and Con-

gress provides such appropriations as it deems wise for furnishing supplies, including in such appropriations the amount required for replacing obsolete and unserviceable material turned in by the Army. Therefore in this case it is right and proper that the proceeds of such material turned in should be covered into the Treasury as is now done.

For the militia this is not the case. On the contrary, there is a standing annual allowance made by Congress for arming and equipping the militia, and it is evident that in providing this allowance it was and is the intention of Congress that the militia should have the full benefit of the allowance made. Under existing laws they do not get this full allowance, but it is evident that the allowance is diminished by the value of whatever unserviceable and old material is turned in. It is this deduction from the allotment of this appropriation to each State which I think should be corrected.

(1) Even without this deduction the allotment to each State under the appropriation is much too small for the purpose intended. States get out of the allotment as much as possible, and some of them supplement it by State appropriations several times as great as their allotments. I believe also, as stated, that the law did not contemplate this deduction, and that it is objectionable for this very reason—that it reduces the allotment, which is already too small, and in a way that was not intended.

(2) There is another objection, in its nature a military one, which is perhaps more important. The States, desiring to husband their allotments and knowing that the value of whatever obsolete and unserviceable material that is turned in is lost to their allotments, the resulting tendency, and consequently the fact, is to prevent the States from turning in such bad material and to induce them to retain arms and equipments which are often of little value and sometimes entirely worthless, thereby lessening the military value of the militia.

If the States could dispose of their own old material it would overcome the objections stated, but for many and important reasons it has been found and is well known that this ought not to be permitted, and that the law requiring that it shall be turned in to this Department to be disposed of is best and should be continued.

This old material, when turned in, is stored with similar old material turned in by the Army to be disposed of to the best advantage and the best interests of the United States from time to time, and I think the law requiring that the proceeds of such sales shall be turned in to the Treasury should be continued as it now stands.

It is a fact, however, that the value of this old and obsolete material when turned in and the prices that can be obtained for it are well known and can be established by this Department with fair accuracy.

The remedy that I would suggest is, then, that when such old material is turned in this Department shall determine its value, report the same to you, and that on your reporting to the Treasury Department the value of such old material turned in the law will require the Treasurer of the United States to credit to the appropriation for arming and equipping the militia the amounts of such sums reported by you. The division of allotment to each State of this appropriation is kept in this Department, and on receiving notification that the above amounts are added to the appropriation as contemplated above this Department would then add the amounts to the allotments to the States to which they belong. To carry out this recommendation I respectfully recommend the enactment of a law substantially as follows:

"*Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled*, That hereafter when any State, Territory, or the District of Columbia turns in to the War Department arms, equipments, or other military supplies, under instructions from the Secretary of War, obsolete or unserviceable, which have been issued by said Department under the law for arming and equipping the militia, the Secretary of War will cause the value of such old and unserviceable or obsolete material turned in to be determined, and will report its value from time to time to the Secretary of the Treasury, who is directed to then credit to the appro-

priation for arming and equipping the militia the amounts so reported to him by the Secretary of War; and the necessary amount is hereby appropriated for the purpose. The Secretary of War, on receiving notification from the Secretary of the Treasury that the amounts have been carried to the appropriation aforesaid, will credit the respective States, Territories, or District of Columbia, as the case may be, with the amounts to which each shall be entitled."

To avoid the loss of their allotments, which have been described, there are frequent applications from governors of States to have obsolete arms and equipments exchanged for new or service arms and equipments of the same kind, and frequent pressure is brought to bear upon this Department to have such exchanges made on the ground that they are fair and just. Under existing laws they can not be permitted, but it is not always easy to satisfy applicants that the reasons for refusal are good.

A law authorizing such exchanges ought not to be enacted, because it is clear that it would affect unevenly the amounts allotted to States, and would change the amounts appropriated by Congress in a way not intended, because the States would receive in lieu of old material new material of much greater value.

Appropriations can not be so made as to provide properly for this, and the result would be constant efforts to turn in damaged material, which ought not to be exchanged.

This communication was submitted to Congress by you, but no action was taken thereon. It is hoped that favorable action thereon may be obtained from Congress at its next session.

ARMY GUN FACTORY AT THE WATERVLIET ARSENAL.

The manufacturers of the gun lathes for the army gun factory at Watervliet Arsenal have made most unexpected and gratifying progress in the completion of these large machines, so that the equipment of the north wing is now complete, and it includes eight 12-inch turning and boring lathes, five 12-inch turning lathes, and one rifling machine. These machines are now in operation.

During the year the erection of the south wing of the army gun factory, authorized by the fortifications act of February 24, 1891, has been completed, and all the smaller machine tools have been delivered and erected. The shrinkage pit in the central section has been completed. The heating arrangements consist of vertical coal furnaces and hot-air ovens. The following large machines have also been delivered and erected: Three 12-inch gun lathes, one 12-inch rifling machine, two 12-inch jacket lathes, one 80-ton electric traveling crane. This crane admits of being rigged for weights of 120 tons. Foundations for the other lathes have been prepared. The shafting and belting, boilers and steam engine, have been delivered and erected and the heating plant completed, except the floor coils between lathes, which are placed as the gun lathes are erected. The fortifications act of July 23, 1892, contains an item of $346,600 for completing the equipment of this wing. The remaining machines now to be provided will include three 16-inch turning and boring lathes, one 16-inch turning lathe, one 16-inch rifling machine, one 16-inch jacket lathe, an additional traveling crane of 60 tons, and a 24-ton crane for use with the 12-inch jacket lathes.

At the present rate of delivery of the large gun lathes it is expected that the equipment of the south wing, exclusive of 16-inch machinery, will be completed by March, 1893; and that the equipment, inclusive of 16-inch machinery, will be completed and in operation by July, 1894. The capacity of this wing will be then fifteen 12-inch guns and three 16-inch guns; and the total capacity of the gun factory, including north and south wings, will be twelve 8-inch, fifteen 10-inch, fifteen 12-inch, and three 16-inch guns per annum.

The work of manufacturing guns in these new shops has gone on satisfactorily since its inception, and the indications are that a greater output than that originally estimated will be attained, as also a marked reduction in the estimated cost of manufacture.

Some additional expenditures are yet needed at the Watervliet Arsenal to facilitate operations there, as renewing the roads for the heavy travel to which they are now subjected, electric lighting the post, and a turbine plant for use in connection therewith. Appropriations have been made in part for these purposes, and estimates to complete them will be submitted for the action of Congress, in order that the equipment of this large and important arsenal may be as complete and efficient as possible.

SANDY HOOK PROVING GROUND.

The Gantry crane for mounting and dismounting heavy guns has been completed and set up at the proving ground. This crane has a capacity of 80 tons, and was designed and constructed by the Shaw Electric Crane Company, of Muskegon, Mich. It was furnished the Department by Messrs. Maxwell, Manning & Moore. The crane works well and will greatly expedite the work carried on at this post, as well as reduce largely the expense.

During the past year the proof butts have been remodeled and enlarged, and new and substantial platforms for testing guns and carriages are now being laid and so arranged as to be conveniently reached by the Gantry crane.

The new barracks for enlisted men of the Ordnance Department, and the new office building to replace the one destroyed by lightning, have been completed and are now occupied.

The largely increasing number of guns, carriages, projectiles, etc., and the considerable quantity of powder required for their test, now received annually at this post, render the services of a locomotive engine a necessity in order that these heavy weights may be promptly and economically transported from the wharf to the testing battery, etc. Accordingly, an estimate for a locomotive will be submitted to Congress at its next session.

The necessary experimental firing and other work which must be performed at the proving ground is constantly and rapidly increasing. The work of coast defense depends on these experiments and can not

progress without them. To this experimental work must now be added the proof of the new guns which are being manufactured. To furnish necessary additional facilities for the proving-ground work, plans are in progress for erecting butts and mounting carriages for the proof of guns at the site of the wharf which was formerly used by the Central Railroad Company of New Jersey (about 1 mile south of the other Government wharf) and for wharf facilities for landing guns at this point, and for connecting tracks to transport the guns to the firing places.

In connection with these plans, Congress made an appropriation at its last session for the purchase of all the tracks and fixtures which belonged to the railroad company on the reservation, and also for the purchase of a strip of land about one-half mile long, and the railroad thereon, which connects these tracks on the reservation with the operated railroads of the Central Railroad Company. The track at the main proving-ground batteries is being extended along the beach past the butts and targets to connect with the above-mentioned railroads and with a switch to the new butts and wharf. This will give a valuable railroad connection between the two wharves and batteries and a valuable railroad connection between the whole system and the railroads of the country for receiving and shipping guns, carriages, etc., whenever on account of ice or other difficulties they can not be transported more economically by water.

This important work is now stopped by the temporary use of the ground for a quarantine camp.

SEACOAST GUN-CARRIAGE FACTORY AT THE WATERTOWN ARSENAL.

The manufacture of iron seacoast carriages has been carried on at this post for many years, and in later years that also of field and siege and even seacoast cannon. In 1887 the Department decided to transfer all gun work to the Watervliet Arsenal—the place selected as the site for an army gun factory, and such machinery as was suited to this purpose was taken from Watertown and other arsenals and concentrated at Watervliet. This step was an absolute necessity at the time, as the production of the guns, in the natural order of things, has to be established first, before proceeding to the establishment of a carriage factory. For two years, viz, 1886 and 1887, Congress made no appropriations for either purpose. In the year 1888, however, Congress recognized the need of an army gun factory and made an appropriation of $700,000, by the fortifications act of September 22, 1888, which enabled the Department to erect the north wing and central section and partially equip the same with machinery adapted to the manufacture of modern heavy guns. The establishment of the gun plant being thus well inaugurated, the next most important object was the installation of an adequate gun-carriage plant, and the Watertown Arsenal was selected as the post best suited to the purpose.

By the fortifications act of July 24, 1891, the sum of $27,000 was appropriated for the improvement of the existing plant at Watertown Arsenal, for the manufacture of seacoast gun carriages. With these funds a commencement was made in the installation of a modern carriage factory. An iron and brass foundry was established (adapting for this purpose an existing timber shed), an 18-ton air furnace and two cupola furnaces of 7 and 8 tons capacity, respectively, were erected, core ovens constructed, and cranes and other appliances provided. In one end of the building a brass foundry with five furnaces was erected. With the remainder of the funds a number of large machines suitable for carriage work, and required to replace in part those removed to Watervliet Arsenal, were procured; also the necessary shafting and belting. Even with this very limited addition to the manufacturing facilities at this point the Department was enabled to undertake the construction of two new types of barbette carriages, of 8 and 12 inch caliber, respectively, and to considerably facilitate the work on alteration of 10 and 15 inch S. B. carriages, which has been carried on here for several years past.

By the fortifications act of July 23, 1892, a further appropriation of $151,000 was made for the enlargement and improvement of the heavy gun-carriage plant at this post.

Under this provision the erection of a new shop building has been commenced, and bids invited for supplying a partial list of the tools and machines required for the equipment of the new and the already existing shops.

Further estimates will be submitted to Congress for completing the installation of this carriage plant, that it may have a capacity adequate to the needs of the service, as outlined in my last report. A careful study of the important considerations involved in the establishment of a Government shop of this nature, and taking into account the present facilities of private manufacturers, has led me to project a plant of sufficient capacity to give an annual output as follows:

8-inch.		10-inch.		12-inch.				Converted.	
Barbette.	Disappearing.	Barbette.	Disappearing.	Barbette.	Gun-lift.	Case-mate.	Mortar.	15-inch.	8-inch.
4	5	2	5	2	3	2	5	15	10

The estimated cost of the tools and machines alone for the equipment of this plant is $336,175, *exclusive* of machinery on hand. By including tools and machines on hand not *permanently* serviceable, but which can be made to answer until replaced by others to be procured from funds that may be obtained hereafter, this amount can be reduced to about $182,000.

The pressing needs of the service for carriages, the production of

which is largely in arrears of that of the guns, demand that the equipment of this plant be pushed to completion as early as practicable, in order that the work of manufacture may be vigorously prosecuted.

ROCK ISLAND ARSENAL.

During the fiscal year ending June 30, 1892, a viaduct was built over the railroad tracks in Rock Island, the frequent passage of trains and the switching of cars at the bridge end having delayed traffic and rendered it dangerous. The iron work was supplied by the Phœnix Iron Company, of Pennsylvania, while the stone and wood work was done by the United States, as owing to the facilities it was found to be more economical to do it thus than to let it out by contract.

The viaduct is a through span of 100 feet, reached from the island by the old bridge, raised to an inclination of 1 in 53 and continued by two 45-foot plate girders laid at the same inclination. Full details of the construction are given in appendix.

Repairs were made to the draw mechanism of the main bridge.

Proposals were called for August 22, 1891, for the drilling required to remove rock from the channel leading into the water-power pool. The proposals stated that about ten thousand holes, averaging 3 feet in depth and of sufficient size to admit dynamite cartridges $1\frac{1}{4}$ inches in diameter would be required. The bids stated the rate per lineal foot to be charged, and the contract was awarded to the Thomson Van Depoele Electric Mining Company for 12 cents per foot. The average cost of drilling by hand the kind of rock for which the electric drills were used was about 20.6 cents per foot. The tin hand pump with leather valves ordinarily used wore out rapidly, and pumps of galvanized iron, with a bullet or marble for a valve, replaced them with great advantage.

This excavation was made to increase the channel that had been cut through the ledge at the head of the water-power pool in former years, from widths of 125 to 150 feet to a width of 200 feet, and to deepen the channel throughout to 4 feet. The general depth of the old channel was 4 feet, but there were deposits in it that required removal. Further details are given in appendix.

Work on the erection of the few buildings still required to complete the plans for the arsenal has been totally suspended because of the failure of Congress to make any appropriation for continuing the work.

The manufacture of field and siege artillery carriages has been transferred to this arsenal, and the plant therefor is being established. A small appropriation for additional machines and fixtures and some improved facilities for prosecuting this work economically are very necessary. The manufacture of nearly all equipments for the Army is already established at this arsenal.

ARMAMENT OF FORTIFICATIONS, ETC.

Powder.

The test of the type 10-inch and 12-inch guns is still in progress. Great and vexatious delays have occurred during the past year in procuring powders that fulfill contract requirements, especially for the tests of type guns, and incidentally the tests of carriages.

In establishing these requirements, the practice of the Department has been to order such number of small samples from the powder-makers as will enable them to work up to the required standard, and after it was once obtained, to place a contract for sufficient quantity to test the gun. The standard of requirements has been based on results obtained with foreign powders tested either in our own or in foreign guns. Generally powder-makers have not had great difficulty in obtaining the required results, but they are frequently unsuccessful in in reproducing in quantity powders that have proved satisfactory.

The contract requirements for brown powders, and which have been attained in actual firings, are as follows:

Caliber.	Length of bore.	Weight of charge.	Weight of shot.	Muzzle velocity.	Pressure per square inch.
	Calibers.	*Pounds.*	*Pounds.*	*Ft-sec.*	*Pounds.*
8-inch	32	125	300	1,950	37,000
10-inch	34	250	575	1,975	37,000
12-inch	34	450	1,000	1,975	37,000

The necessity is constantly and strongly forced upon me that this Department should have facilities for making improvement in military powders, establishing standards of the same, and possibly eventually for making small quantities of the same for experiment and samples. Without special appropriation therefor, the Department is doing all that is practicable by study and the establishment of a small chemical laboratory and chemical analysis and experiment to prepare for taking up the above work.

A sample of French B. N. smokeless powder was procured for test in the 10-inch B. L. rifle, as noted in my last report. This powder proved too slow and the results were poor, due to the imperfect combustion of the powder. It was thought that this powder might prove suitable for the 12-inch B. L. rifle. It was accordingly tested in that gun with the following results:

Caliber.	Powder.		Weight of projectile.	Velocity at muzzle.	Pressure per square inch.	Muzzle energy.
	Kind.	Weight.				
		Pounds.	*Pounds.*	*Ft.-sec.*	*Pounds.*	*Foot-tons.*
12-inch	French B. N. smokeless	221	999	2,010	35,727	28,006

The following results were obtained by firing samples of this powder at the temperature of the air and after heating up to temperature of 120° F.

Caliber.	Powder.			Weight of projectile.	Velocity at muzzle.	Pressure per square inch.	Muzzle energy.
	Kind.	Weight.	Temperature.				
		Pounds.	*°F.*	*Pounds.*	*Ft-sec.*	*Pounds.*	*Foot-tons.*
12-inch	French B. N. smokeless.	204	83	1,000	1,847	26,371	23,671
12-inch		204	120	999	1,930	29,861	25,821

It was noticeable, in firing this powder, that the blast of the discharge was much greater than with the brown powder, and was felt to a considerable distance in rear of the piece, breaking windows, etc., in buildings, even in one that was located behind a traverse in rear of the gun.

The sample of German smokeless powder procured for the 8-inch rifle when tested, after being raised to a temperature of 125°, showed a slight increase in velocity and no material change in pressure. After storing the German powder in sealed cases for a year the velocity fell off about 30 feet-seconds in 2,000.

These samples of French and German smokeless powders will be further subjected to exhaustive tests to ascertain their respective keeping and erosive qualities, resistance to moisture, etc.

When ignited in the open air and without confinement these smokeless powders burn quietly until consumed.

Experiments were made with the German powder to ascertain whether it was susceptible of being violently exploded or detonated; or, in other words, whether it possessed the quality of a high explosive. Some 8-inch cast-iron shell charged with 6 pounds of the powder were buried in earth and exploded by means of a detonating fuse (24 grains of mercuric fulminate). Nothing in the nature of a detonation occurred; burning grains were thrown high in the air, and many partially burned grains were recovered in and around the crater formed by the explosive.

The dimensions of the craters were less than those formed by exploding, in a similar manner, charges of black rifle powder of 7½ pounds weight, but having the same volume as the smokeless powder.

So far as the tests have proceeded, either of these two types of smokeless powders would seem to be well adapted for use with heavy guns.

The German powder has, however, the advantage of giving as good velocity as the French, with a somewhat less charge. The weight of charge with the German is about one-third and with the French about one half that of Brown powder.

The German powder has the further marked advantage that it is readily made up into cartridges while a great deal of time is required for putting up the French powder.

A report of tests and investigation of small-arms powders is made further on in this report under the subject of "Small arms."

Seacoast guns.

The type 10-inch B. L. rifle has been fired to date 158 rounds and the type 12-inch B. L. rifle 64 rounds.

The Department will have completed by the end of the calendar year 1892 fifteen 8-inch guns, eight 10-inch guns, and three 12-inch guns, which will be available for issue to the service as soon as the necessary carriages for mounting them are provided.

The fortifications act approved July 23, 1892, appropriates $800,000 for a further supply of gun forgings of 8, 10, and 12 inch caliber. This sum will suffice to procure ten sets of 8-inch gun forgings, twelve sets of 10-inch gun forgings, and ten sets of 12-inch gun forgings. The total number of guns thus far provided for by appropriations up to date is forty-five 8-inch guns, forty-six 10-inch guns, and thirty-five 12-inch guns, exclusive of the twenty-five 8-inch, fifty 10-inch, and twenty-five 12-inch guns provided for under contract with the Bethlehem Iron Company.

The 10-inch rifle has been used also for the test of the 10-inch pneumatic disappearing carriage; while the 12-inch B. L. rifle is now mounted on the gun lift at Sandy Hook, the test of which will be made by the firings required to test the gun, thus saving the cost of a separate test. In testing samples of powders, this type 12-inch gun has been subjected to some excessive pressures, running as high as 28 tons per square inch, but without sustaining injury other than some burring of the breech screw-threads, which was soon remedied.

The type 8-inch B. L. rifle manufactured at the Watervliet Arsenal has been fired 174 rounds, but as the original 8-inch gun, which is of quite similar construction, was fired 300 rounds, the strength of the type 8-inch gun is abundantly assured.

The accuracy of fire of these new guns may be judged from the following target record made with the 8-inch B. L. rifle, using the new open sights adopted for the service:

Range	mile..	1
Mean vertical deviation from center of impact	foot..	.56
Mean horizontal deviation from center of impact	do...	.56
Range	yards..	3,000
Mean vertical deviation from center of impact	foot..	1
Mean horizontal deviation from center of impact	feet..	1.75

This extreme accuracy of fire is better illustrated by the statement that with the 8-inch gun in a target of five shots at a range of 1 mile four out of the five shots struck within an area 20 by 21 inches, and in a target of eight shots at a range of 3,000 yards (about $1\frac{3}{4}$ miles) six shots struck within an area $1\frac{1}{2}$ by 4 feet.

The targets made with the 10-inch B. L. rifle have shown about the same degree of accuracy,

Experimental guns.

10-inch B. L. rifle, cast iron, hooped with steel wire.—During the past year the test of this gun by the Board for Testing Rifled Cannon, etc., has been completed. The gun, which is on the Woodbridge plan, substantially as recommended by the Getty board, except that the wire is carried forward of the trunnions, was begun in 1884 under the provisions of the fortification act approved March 3, 1883. A full description of the gun is given in Appendix 25 to the Annual Report of the Chief of Ordnance for 1886.

The weight of the piece is about 28 tons; length of bore, 28 calibers. The gun has been fired in all 161 rounds, of which number 114 rounds were fired under the supervision of the Board for Testing Rifled Cannon, etc.

With a charge of 160 pounds brown prismatic powder and a shot of 453 pounds, mean weight, the mean velocity was about 1,840 feet-seconds, with a mean maximum pressure in the chamber of about 30,245 pounds. The resulting muzzle energy was 10,632 foot-tons. The muzzle energy of a 10-inch steel gun of 30 tons weight and 34 calibers length of bore is about 16,000 foot-tons.

The conclusion reached by the board with regard to this 10-inch wire-wrapped gun was that as the gun consists essentially of a cast-iron body strengthened by steel-wire winding, as it is a gun of inferior power to the standard guns of the day of the same caliber, as the lim ited tests to which it has been subjected have developed deep scorings and gutterings, which have been found to be common to cast-iron bores, the board, while it does not consider that the gun has developed weaknesses which would condemn it for service, can not, upon the whole, from the experience so far, recommend it as in any respects suitable to be put in use in the Government service. The complete report of the board is contained in an appendix to this report.

12-inch B. L. rifle, cast iron, tubed with steel.—This gun is still in the hands of the Board for Testing Rifled Cannon, etc., the pressure of more urgent work having prevented the completion of the test during the past year. There remain, however, but a few rounds more to be fired in order to complete the test, and these will be fired within the next few weeks. The gun has been fired thus far 228 rounds, and the advantage derived from the use of a steel lining in protecting the bore against erosion from the powder gases has been clearly established.

Mortars.

The test of the type 12-inch B. L. mortar, cast iron, hooped, has been completed by the Board for Testing Rifled Cannon, etc., and adjudged to be satisfactory for issue to the service. This piece has been fired 364 rounds without material injury.

It represents, or is the type of, seventy-three mortars completed or

under contract, differing from them only in respect to rifling, which in the type piece is uniform, having a twist of one turn in 35 calibers, while in the other mortars the twist increases from one turn in 50 to one turn in 25 calibers.

During the test of the type mortar a comparison was made of accuracy of fire between the type mortar and a similar piece, but having a caliber of 12.2-inches and rifled with an increasing twist, as above described.

This test showed the marked superiority, in point of accuracy, of the increasing over the uniform twist, and it was adopted for the 12-inch mortars under manufacture.

The rate of fire for this piece is estimated to be at least one shot in eleven and one-half minutes with the present imperfect mounting; but with a more suitable type of carriage, such as those now under manufacture, this rate of fire will be considerably increased.

This type mortar was designed to fire a maximum charge of 80 pounds of brown prismatic powder with a shell of about 630 pounds weight. This shell, however, was estimated to possess insufficient power for penetrating, at shortest ranges, the thicker steel decks which are now coming into use.

About this time the type steel mortar was produced, designed for a charge of 105 pounds of powder with a shell of 800 pounds, and it became very desirable to use, as far as practicable, the same powder and projectiles for both types of mortar. Firings were, therefore, made with the same weight of projectile, and a powder has been obtained which is suitable for both pieces, as will appear from the following results:

Kind of piece.	Weight of piece.	Length of bore.	Powder.		Weight of shell.	Muzzle velocity.	Pressure per square inch.	Range, approximate.
			Kind.	Weight.				
	Tons.	*Calibers*		*Pounds.*	*Pounds.*	*Foot-seconds.*	*Pounds.*	*Miles.*
12-inch mortar, cast-iron, hooped.	14.25	9	Du Pont brown prismatic V.M.	80	800	1,020	27,500	5
12-inch mortar, steel.	13	10	....do	105	800	1,145	30,000	6

This powder and the 800-pound shell will be adopted for the service. As the charges are much reduced for ranges under 2½ miles, causing a great reduction also in the pressures, a 1,000-pound shell will also be adopted for both mortars for ranges below that limit, in order to give the necessary penetrating power to the mortar shell.

The test of the steel mortar has been delayed mainly from lack of a suitable carriage from which to make firings.

Several carriages on which its trial was essayed have broken down after a very few rounds.

One of these carriages, originally constructed for the 12-inch cast-iron hooped mortar, has been strengthened and will soon be in condition to permit the test to be continued.

The construction of the steel mortar is similar to that of the 8-inch gun, the tube being inserted into a jacket from the rear and held up against a shoulder by a screw bushing, which is threaded on the interior to receive the breech block. The tube and jacket are hooped throughout with a single layer of hoops.

There will be completed by the end of the calendar year 1892 forty-four 12-inch B. L. mortars, cast iron, hooped with steel.

The fortifications act of July 23, 1892, appropriates $100,000 for continuing the manufacture of these all-steel 12-inch mortars, and is sufficient to provide about seven such mortars. The contract for the forgings has been awarded to the Bethlehem Iron Company.

Seacoast carriages.

The manufacture of the experimental and service carriages noted in my last annual report has been prosecuted as vigorously as possible during the year, but as the designs are entirely new and require iron and steel castings of shapes and dimensions not hitherto supplied by the trade or made in Government shops, failures in part have met the first attempts to produce them, and as a consequence the work has been considerably delayed. The type carriages being experimental also, many of the minor details have required further study and modification or rearrangement as the manufacture has proceeded, in order to obtain the best construction.

The settlement of these points could only be made after the carriages were placed under manufacture, as considerable freedom had to be left to the manufacturer himself as to the best arrangement of details.

As respects the spring return mortar carriage, the type carriage of this class made by Easton & Anderson, of Erith, Kent, England, developed some defects in trial, which, though serious, admitted of being easily remedied.

On the other hand, its many approved good qualities, its simplicity of construction, efficiency, and cheapness, were such strong arguments in its favor that the Department decided to reconstruct the cheeks of the type carriage and correct other defects brought out by the trials, as far as practicable, while still retaining the remaining parts, the bed-plates, etc., of the original construction.

A carriage thus rehabilitated has been subjected to severe trial by the Ordnance Board, and is pronounced by the board as satisfactory for service as it is now being constructed on the approved designs of the Department.

The Builders' Iron Foundry, of Providence, R.I., has completed the first of these mortar carriages under its contract, and work on the remainder is so well advanced that the entire eight carriages should be completed by the end of 1892.

The Morgan Engineering Works is associated with the Builders' Iron

Foundry in the manufacture of these carriages, and a portion of them will be made at their works at Alliance, Ohio. The Department has sufficient funds now available to manufacture about forty carriages more.

The Belleville springs required for these carriages are under manufacture at the Watertown Arsenal. Preliminary experiments in their manufacture at this post demonstrated that the springs could be manufactured there successfully, with very great economy, and with but trifling outlay for the necessary plant.

The Canet 12-inch mortar carriage manufactured for the Department by Sir Joseph Whitworth & Co., Manchester, England, has also been tested by the Ordnance Department. This carriage is practically made of steel, largely of steel castings. It is arranged for all-round firing, and for elevations from the horizontal up to 75°. The line of fire always coincides with the direction of recoil, whatever be the angle of elevation, so that the shock on carriage and platform due to firing is very much reduced.

In this respect, which is a primary requirement in present types of mortar carriages, the construction leaves little to be desired.

The recoil is controlled by brake cylinders, containing liquid, which are constructed to regulate the recoil by a taper bar entering the hollow piston rod, thereby controlling the orifice for escape of the liquid past the valves.

After discharge the mortar is returned to the firing position by means of compressed air stored in a cylinder, termed a recuperator. The initial pressure in the recuperator is from 850 to 950 pounds per square inch. On recoil, the liquid displaced by the immersion of the piston rods in the brake cylinder enters the recuperator and, acting on the recuperator piston, further compresses the air in the air chamber, thus storing up sufficient energy to return the gun to the firing position.

During the trial it was found necessary to make a change in the gear of the elevating mechanism for the purpose of obtaining more power. Generally speaking, in its action the carriage accomplished what was intended, though entailing an undue expenditure of time and labor. The leakage of the air from the recuperator was very slight. The rate of fire, however, was undesirably slow, due mainly to the difficulty of elevating and depressing the piece.

This carriage is not deemed by the board as suitable for our service as the more simple spring return-carriage, but it is a *practicable* type, and its construction can be readily modified to admit of a considerably more rapid rate of fire.

The experimental 10-inch pneumatic disappearing carriage manufactured by the Pneumatic Gun Carriage and Power Company is now being subjected to the trials imposed by their contract, under the supervision of the Board of Ordnance and Fortification.

After these trials are completed it is presumed that the carriage will

be turned over by the board to the Department for more exhaustive test.

The work on the two other types of disappearing carriage which the Department has under manufacture is progressing. The Gordon 10-inch carriage is nearly completed, and the 8-inch and 10-inch carriages on the Buffington-Crozier plan will be completed during the coming winter or early spring.

The manufacture of the 8-inch and 12-inch type barbette carriages at Watertown has been considerably delayed by the necessity of first procuring and setting up an air furnace and some additional machinery, and, further, by the failure of some of the first castings made. The work, however, is now progressing satisfactorily, and these two types will be completed and subjected to test during the coming year. The Department has a limited appropriation available for continuing the manufacture of these carriages.

The alteration of 10-inch and 15-inch S. B. carriages has been continued at Watertown Arsenal during the past year. The fortifications act of July 23, 1892, contains an item of $50,000 for the alteration of about nine 10-inch and nine 15-inch additional carriages, which will be executed during the coming year. The Department will then have the following total number of these altered carriages, viz:

One hundred and thirty-six 10-inch carriages for service with 8-inch converted rifle.

Sixty 15-inch carriages for 15-inch gun using increased charge of powder.

A contract has been made with Grusonwerk, of Magdeburg-Buckau, for a 12-inch casemate carriage, including the right to manufacture.

This carriage will be completed in about one year, and is to be of the minimum-port type, with the construction of which the Grusonwerk is so widely known.

The 12-inch gun-lift carriage manufactured for the Department at the Creusot Works, France, has been received at the Sandy Hook proving ground, and set up on the gun lift recently erected at that point by the Engineer Department. It is now undergoing test. It is practically a gravity-return barbette carriage, and can be easily reproduced.

Curvature of chase.

The extreme length of modern high-power steel guns in proportion to diameter, the result partly of the greatly increased strength of material used in gun construction, and the long sustained high pressures attained by changes in powder have resulted in a liability to axial curvature in the long chase of comparatively small diameter.

One of the strains which tends to cause this curvature is that of the inertia of the gun when fired at high angles and with a considerable angle between the line of fire and the direction of the recoil. It can be readily seen that when this angle is great the extreme length of the

gun gives the inertia developed in recoil a powerful bending moment around the trunnions.

The high pressures used in modern guns, causing greater increments of velocity of recoil, have increased the inertia developed, and the great length of the gun compared with the diameter of the chase has so increased this bending force in proportion to the stiffness of the gun as to give it an importance which it did not formerly possess.

It is possible that the effect of this strain is such that it may become necessary to so alter the construction of our carriages as to materially reduce the angle between the line of fire and the line of recoil, so as to materially reduce the bending moment above described, thereby reducing that component of the inertia which acts in a direction perpendicular to the axis of the gun. Of course a theoretically perfect carriage in this one respect would be one in which elevations of the gun were effected by elevating and depressing one end of the chassis and maintaining always exact parallelism between the axis of the gun and the direction of recoil. This exact parallelism is not necessary, but a nearer approximation to it may become necessary.

The strains above mentioned and their effect is receiving careful analytical investigation. The whole subject is being carefully considered, and the Department has now under study a design for a barbette carriage in which the direction of recoil shall be more nearly parallel to the line of fire.

Seacoast projectiles.

The fortifications act of July 23, 1892, contains an item of $50,000 for 12-inch steel armor-piercing shot. This sum is sufficient to procure about one hundred 12-inch armor-piercing shot, and a contract for that number has been awarded to the Midvale Steel Company.

The Department has now under contract with the Midvale Steel Company the following quantities of steel armor-piercing projectiles, viz:

8-inch	318
10-inch	422
12-inch	148

The experiments with steel deck-piercing shell for the 12-inch mortar are not as yet completed, and the design of this shell and the mode of manufacture are not yet definitely settled.

Further trials will be made, and it is proposed to test cast-steel shell of special manufacture. So great a number of these steel mortar shells is required for service that it is important to find some more economical material and mode of manufacture than that employed for armor-piercing projectiles for guns, and efforts are being made to accomplish this.

These projectiles are required only to pass unbroken through deck armor and it is hoped that some cheap special process for their manufacture can be attained.

SIEGE MATERIAL.

The ten 5-inch B. L. rifles and ten 7-inch howitzers, noted in my last report as under manufacture at the Watervliet Arsenal, will be completed this year. Congress at its last session appropriated sufficient funds to manufacture ten more of each of these types of cannon and they will be completed during the next fiscal year.

The contract for the forgings has already been awarded to the Midvale Steel Company.

The type of carriage for the 5-inch rifle has been decided upon and twenty of these carriages have been placed under manufacture at the Rock Island Arsenal.

The type carriage for the 7-inch B. L. howitzer is now undergoing test. The Department has sufficient funds available for the manufacture of about twenty howitzer carriages, which will be commenced at Rock Island Arsenal as soon as the test of the type carriage is completed.

Several years ago the Department ordered from Messrs. Easton & Anderson a 5-inch siege carriage of the Raskazoff type. This carriage has just been completed and will be sent to the proving ground for test.

7-inch B.L. siege mortar.—The Department has under manufacture a 7-inch B.L. mortar for the siege service which will be completed and tested during the coming year.

The general data relative to this piece are as follows:

Weight	pounds..	1,715
Total length	inches..	58.3
Length of bore	calibers..	7
Charge	pounds..	5.5
Shell	do....	125
Velocity	feet-seconds..	690
Pressure	pounds..	18,000
Range at 45°	yards..	4,340

The mortar is adapted to fire the projectiles of the 7-inch howitzer and permit the common use of the projectiles for that piece in service. It is also intended to fire a steel shell of 150 pounds weight and approximately 5 calibers length, charged with high explosives for great destructive effect. Reduced charges of powder will be used to make the effective limits of fire cover ranges between about 650 yards at 15° elevation and 4,340 yards at 45° elevation. This piece will supply the heaviest caliber that will probably be needed at present for vertical fire in our service to be used in siege operations against strongly intrenched and covered positions. Pieces of similar description have already been provided for our field and seacoast defenses, but are lacking in the siege armament. The recognized efficiency of the fire from rifled mortars renders it imperative that this deficiency should be supplied. The questions of the best caliber, power, and efficiency of siege mortar to be adopted for our service, as affected by weight and transportation,

both of gun and projectiles, have been carefully considered. It is thought desirable (at present at least) to have but one caliber of siege mortar, and there is some advantage in having this caliber the same as that of the siege howitzer.

FIELD MATERIAL.

3.2-inch B. L. field guns, steel.—By the end of 1892 the Department will have completed at the gun factory an additional lot of twenty-five 3.2-inch steel field guns, making the total number thus far manufactured for service 125 guns. The fortifications act of July 23, 1892, contains an appropriation for twenty-five more guns, which, like the lot now under manufacture, will be of the new model 1890.

The manufacture of field carriages, heretofore carried on at the Springfield Armory and Watervliet Arsenal, has been transferred to the Rock Island Arsenal. The preparations for doing the work there are nearly completed, and the manufacture will soon be in active progress.

Some firings have been made with the 3.2-inch gun at the proving ground, using French smokeless powder. A charge of one pound and fourteen ounces of this powder, with a 13.5-pound shell, gave a velocity of about 1,680 feet and a pressure of only 21,000 pounds. The charge with black hexagonal powder is 3½ pounds for the same velocity, and the pressure about 35,000 pounds. Some firings have also been made with a smokeless powder of American manufacture, and the results, for a first attempt, are considered promising.

3.6-inch B. L. field guns, steel.—The test of the type 3.6-inch B. L. rifle, steel, has been completed by the Board for Testing Rifled Cannon, etc. The piece has been fired over 1,900 rounds, and has been adjudged by the board as satisfactory, under the law, for issue to the service. The drawings of this gun are given in the Report of the Chief of Ordnance for 1890, Appendix 23. The report of the board, firings, etc., are published herewith as an appendix.

The Department has twenty-four of these guns under manufacture at the gun factory, and they will be completed during the present year. Carriages are to be provided for them by making some minor modification in the heavy type of 3.2-inch carriage as originally made for issue to the service, of which there are about fifty on hand and available.

3.6-inch B. L. field mortar, steel.—Firings with the type piece, an account of the test of which was published in Appendix 37 of my last annual report, have been continued in testing an equipment comprising a platform and pointing scale and in determining a convenient form of cartridge. The mortar is fired from a solidly constructed platform weighing about 200 pounds. The platform is held in a fixed position by stakes, and the recoil of the piece kept within limits by rope fastened to an anchor stake. The elevation is given by quadrant and the direction by means of a front pintle and a hand rule whereon is a sliding

index and scale of chords, which enable the piece to be relaid accurately or corrected for observed deviation in successive firings. Excellent results were obtained in testing this device, as stated in Appendix 32 of this report, with accompanying firing records. A weakness developed in the test of the first platform made has led to the construction shown in the drawings now published, wherein the form of the mortise for the side rails has been changed and iron rivets substituted for wooden assembling pins. The toggles shown have likewise been substituted for rings for fastening the rope to the carriage, after a trial which proved satisfactory.

The standard powder for this piece is the sphero-hexagonal, adopted for common use, also in the 3.2-inch and 3.6-inch field guns. The charges, which are required to cover all ranges from about 300 to 3,300 yards, with angles of elevation between 15 and 45 degrees, are five in number, viz, 3, 5, 8, 11, and 15 ounces. These charges are made up of three cartridges containing 3, 5, and 15 ounces, respectively. The 8 and 11 ounce charges are made up of packages of the 3 and 5 ounce cartridge bags tied together with cord to facilitate loading. The 15-ounce charge is in one bag, to be made of appropriate dimensions, as illustrated for the 11-ounce cartridge bag in Plate III, Appendix 32. The I. K. H. field-gun powder may also be used, the cartridges being the same as for the sphero-hexagonal powder, except that the maximum charge may be 16 instead of 15 ounces. With this charge the range of the mortar at 45° elevation is about 3,450 yards.

Sixteen of these mortars, with carriages (cast steel) and the equipments described, are nearly in readiness for service. Delays have been occasioned in obtaining the steel castings for the carriage-frames, which are made in one piece. A large proportion of the castings made have been necessarily thrown out for various imperfections.

A new form of gunners' quadrant has been tested at Sandy Hook, which is deemed much superior to the one now in use and for which it will be ultimately substituted for general use in the service. This quadrant, shown in Plate IV, Appendix 32, is similar to one used in the French service. The arc is 45°, but by applying different sides, an elevation of 90° can be given. The least reading is one minute, which is given by the setting of a sliding level on a slightly curved arm. The setting to any given degree is made by moving the arm by hand, which is quickly and easily done by pressing back the head of the arm to release it from engagement with the notches on the interior of the arc, then moving the arm to the required position and allowing the spring to react.

PROJECTILES FOR THE FIELD SERVICE.

Field 3.2-inch shrapnel.—During the year the Department has awarded a further contract to the American Projectile Company for 1,500 electrically welded shrapnel, and has also made a contract with the Hotch-

kiss Ordnance Company for 1,000 steel shrapnel, thus making a total of 4,000 shrapnel under manufacture. Appendix 46 contains the specifications and drawings for these shrapnel.

Some experimental 3.2-inch shrapnel designed and manufactured at the Frankford Arsenal have been tested with excellent results at the proving ground, and 1,500 similar shrapnel have been placed under manufacture at that arsenal. A description of this shrapnel and report of the firing tests referred to are given in Appendix 46.

FUSES.

The Frankford Arsenal point-combination fuse with tubular time train has given continued satisfactory results in firing. Two sizes of this fuse are now under manufacture. The fifteen-seconds fuse is adapted for high velocity fire with field and siege guns, and the twenty-eight-seconds fuse for firing with siege howitzers and field and siege mortars. The two fuses are substantially of the same pattern, having the same thread and base and differing only in length of head. Their weights are, respectively, 16 and 17.75 ounces. Experiments have shown that the fuse is safe from danger of premature explosion from such jostling as it may receive in transportation in the field, so that it may be carried fixed in the shell or shrapnel, and that it is subject to slight deterioration from the effects of exposure to vapor or heat. It is rendered waterproof by an outside covering of tin foil. Appendix 44 contains reports of experiments made at Frankford Arsenal and the Sandy Hook proving ground, with an account of the methods adopted for determining the graduation of the fifteen-seconds fuse. The graduation is based upon the time of burning in flight as determined from measured ranges and the computed times of flight in firings with the 3.2-inch field gun at the proving ground, and thus presents a scale of divisions synonymous with the times of flight pertaining to given ranges. The ranges and corresponding times of flight were taken at seven points of the trajectory between about 900 and 4,250 yards, the time of flight for the latter range being thirteen seconds, nearly.

The scale is divided into units and sixths and a given reading, as $1\frac{5}{6}$, for example, referred to the range table of the gun, will indicate the range as well as the time of flight corresponding to that cutting of the fuse under normal firing conditions. This method of graduation has been preferred to one giving the range directly in yards, since it will permit the interchange of fuse in projectiles for guns of different caliber, and as the cut of the fuse will indicate the time of flight to point of burst, it will serve as an auxiliary in determining unknown ranges.

A sample fuse of aluminium of the fifteen-seconds pattern has been prepared. Its weight complete is about 7.75 ounces.

The Merriam base percussion fuse was a subject of test during 1890, 1891, and 1892. From a rather crude device it has been gradually im-

proved until it is now perfected sufficiently for use in mortar shell. The report of the commanding officer of Sandy Hook proving ground, published as an appendix to this report, gives a description, drawing, and firing records relating to the action of the fuse.

MOUNTAIN MATERIAL.

Hotchkiss 3-inch B. L. mountain gun.—A type gun of this character is under test at the proving ground, and a progress report, with firings and target records, made under supervision of the Board for Testing Rifled Cannon, etc., is published herewith as an appendix. The piece has been fired thus far about 550 rounds, and, so far as the tests have been carried, the piece has proved satisfactory in every respect. The tests for endurance will comprise about 1,000 rounds, but there is every indication that the gun will endure that number without material injury.

The piece procured for test was designed to fire fixed ammunition, but to meet the needs of service, requiring the use of full and half charges, it is proposed to separate the projectile from the cartridge case and load them into the gun separately. The cartridges will then be put in the case in two half charges, one of which can be readily removed when it is desired to fire with one-half charges only. The charge is ignited by a friction primer. The piece is mounted on a two-wheel carriage and provided with a limber for traveling purposes and for transportation of ammunition.

The general data relative to this gun are as follows:

Weight of gun	pounds..	218
Total length	inches..	45.7
Length of bore	calibers..	14
Weight of charge (I. K. powder)	ounces..	11
Weight of projectile	pounds..	12
Muzzle velocity	feet..	770
Pressure	pounds..	14,118
Range at elevation of 20°	yards..	3,475
Weight of steel carriage	pounds..	319
Weight of limber, loaded	do....	1,005
Total weight of piece and full equipment	do....	1,545

The Department has placed a contract with the Hotchkiss Ordnance Company for a battery of four of these guns, complete. The ammunition consists of both shell and shrapnel.

PNEUMATIC DYNAMITE GUNS.

No progress in procuring these guns has been made since the report of 1891. Much work has already been done, but it can not be completed on account of the financial difficulties in which the gun company has been involved. Recent information indicates that the company is making arrangements to reorganize speedily and proceed with the further manufacture and completion of the guns.

PRINCIPAL ESTIMATES FOR ARMAMENT OF FORTIFICATIONS FOR FISCAL YEAR ENDING JUNE 30, 1894.

The principal estimates for the next fiscal year, under the head of "Armament of fortifications," are as follows:

For field and siege material $218,000

To procure about twenty-five 3.2-inch B. L. field guns, steel, and their carriages, complete; ten 5-inch B. L. siege rifles, steel, and ten 7-inch B. L. siege howitzers, steel, and their carriages.

For alteration of carriages $50,000

To provide for the alteration of about nine 10-inch S. B. carriages for use with the 8-inch M. L. rifle, converted, and nine 15-inch S. B. carriages for use with the 15-inch gun, firing increased charges.

For steel deck-piercing shell for 12-inch B. L. mortars $54,000

Sufficient to procure about two hundred shell.

For steel armor-piercing shot $100,000

To procure about two hundred 12-inch shot.

The Department has now under manufacture, by contract with the Midvale Steel Company, the following quantities of armor-piercing shot, to be made by the Holtzer process, viz:

8-inch shot	318
10-inch shot	422
12-inch shot	148

In connection with these two items for projectiles estimates have been submitted to cover the purchase and erection of deck and armor plates for proving them.

For steel B.L. rifled mortars $500,000

Estimated to procure about thirty-five mortars, including the forgings therefor. The fortifications act of July 23, 1892, makes sufficient appropriation for about seven of these mortars, and a contract has been placed for the forgings with the Bethlehem Iron Company.

For oil-tempered and annealed steel for 8, 10, and 12 inch guns, including one set of forgings for a 16-inch gun $1,180,000

The appropriation made by Congress at its last session for heavy-gun forgings was less than the estimate submitted by the Department. To meet the deficiency, therefore, occurring under the last appropriations in the supply of forgings for the gun factory the number of sets embraced in the above estimate was increased accordingly.

The above sum is estimated to procure fourteen sets of 8-inch forgings, fifteen sets of 10-inch forgings, fourteen sets of 12-inch forgings, and one set of 16-inch forgings.

As Congress has now appropriated the money for equipping the army gun factory, in part, with 16-inch machinery, and the steel works have the facilities to produce the heavy forgings for pieces of 16-inch caliber, it is earnestly hoped that the necessary funds to enable the

Department to proceed with the manufacture of the type 16-inch gun will be not longer withheld.

For carriages for 12-inch B. L. mortars..... $289,000

The Department will have completed sixty-nine 12-inch B. L. mortars, cast-iron, hooped, by June 30, 1894. The above sum is sufficient, with the $525,000 already appropriated, to provide a like number of carriages. At present there are eight of these carriages under manufacture by contract with the Builders' Iron Foundry, Providence, R. I., which company has associated with it in the work of making carriages the Morgan Engineering Company, of Alliance, Ohio.

Carriages for mounting steel breech-loading seacoast cannon..... $1,693,000

By June 30, 1894, there will be completed forty-one 8-inch B. L. guns, twenty-eight 10-inch B. L. guns, twelve 12-inch B. L. guns.

The following carriages will be required for these guns:

8-inch.—Ten barbette carriages and thirty-one disappearing carriages.

10-inch.—Six barbette carriages and twenty-two disappearing carriages.

12-inch.—Three barbette carriages, eight gun-lift carriages, and one casemate carriage.

Deducting from the aggregate cost of these carriages the money already appropriated for their manufacture, there will remain still to be appropriated about $1,700,000. The estimate submitted, however, is for $1,000,000 only, as owing to the backward state of the carriage plant at Watertown Arsenal, and the limited facilities of private manufacturers, that sum is deemed sufficient for present purposes.

For the enlargement and improvement of the heavy gun-carriage plant at Watertown Arsenal..... $96,600

To complete the equipment of the shops so as to provide a capacity for the output stated in a preceding part of this report.

For electric-lighting plant at Watervliet Arsenal..... $23,500

This estimate includes one 150 horse-power steam engine for driving the dynamo.

THE MAGAZINE SMALL ARM.

The report of the Board on Magazine Small Arms, convened by General Orders No. 136, headquarters of the Army, Adjutant-General's Office, November 24, 1890, was received during the first week of September, 1892. The board commenced its sessions December 16, 1890. Inventors were at once invited to forward arms to the board, and all needful information from the board and all practicable assistance from the Ordnance Department in preparing arms was furnished to the inventors. After being in session for a year and two months, it was found that, in consequence of delay on the part of inventors in presenting their arms, little progress had been made; that the work of the board was being unduly protracted, and that there was little prospect that the

board would ever conclude its labors and arrive at a new arm, and in the meantime this country was years behind other nations in the adoption of a modern type, small caliber, high velocity magazine arm, and was suffering in military reputation therefrom. It was then decided that to enable the board to end its labors at all, and secure a new arm, it was necessary to fix some time after which new arms would not be received, and thus permit the board to conclude its labors. On January 25, 1892, at my request, the Secretary of War fixed the limit of time at June 1, 1892, which limit it was thought would give all inventors ample time, and inventors were duly notified. Subsequently this time was extended to July 1, 1892, but with instructions that inventors should be informed that no further extension would be granted.

The report of the board was made after an examination of fifty-three guns presented by American and foreign inventors, many of the guns being the adopted arms of the principal military powers of Europe. The arms were all subjected to a uniform test, which was careful and exhaustive.

The board selected the model known as the Krag-Jörgensen No. 5, as possessing the best magazine system presented, and as a suitable and satisfactory system to be adopted by the United States military service. This arm can also be used as a single loader, and the board finds that as a single loader it is the best arm that was presented. The board tested the Springfield rifle of reduced caliber as a single loader, and reported adversely to its use.

It was recommended, therefore, that the Secretary of War should approve the selection of the Krag-Jörgensen system for trial, with a view to adoption in the military service of the United States. This recommendation having been approved, immediate steps were taken with a view to substitute the manufacture of this arm for the .45 caliber Springfield at the Springfield Armory as soon as the necessary arrangements can be made. And a board of ordnance officers was at once appointed with instructions to make a study of and to recommend a suitable caliber for the new rifle, and suitable rifling, sights and ammunition, besides the bayonet, ramrod, and other appendages required for issue with the rifle and carbine.

The report of the Board on Magazine Small Arms in full is contained in Appendix 9. It comprises the record of proceedings, together with drawings and description of the principal magazine arms and synopsis of tests of all the arms before the board.

Small-arm sights and bayonets.—In connection with the work of the Board on Magazine Arms, advantage was taken of the opportunity to secure a descriptive report of the sights and bayonets used on foreign arms. A report on this subject, rendered by the recorder of the board at my request, is contained in Appendix 10. It is a distinguishing feature of the sights as compared with our own service sight that none are adapted for accurate target shooting, nor would they prove satis-

factory for sharpshooters' use in action. The rear sights are generally adapted only for fixed elevations, and have no arrangements by which compensation can be made for drift or windage allowance, and for ordinary ranges only, the plain open notch, either square or V-shaped is provided. It appears that the extreme graduations of the sights range from 1,640 yards, in the Belgium service, to 3,500 yards, in the British, whilst the average is approximately 2,200 yards. All the bayonets are of the knife pattern, with blades varying in length from 9.75 to 12 inches, and about 1 inch in width. They are fitted with short guards and handles of wood and steel about 4 inches in length. The weights vary between 8.5 and 15.5 ounces.

Rifle barrels.—A special quality of steel, having a tensile strength of 85,000 pounds, elastic limit 45,000 pounds with an elongation of 25 per cent, has been used in making the experimental .30-caliber rifle barrels, and, in connection with the work of the Board on Magazine Small Arms, are prepared for experiments at the Springfield Armory and the Frankford Arsenal. Continued firings with smokeless powder developing high pressures have caused enlargement and degradation of the bore, which may be in part attributed to the quality of steel in the barrel. Investigations in this matter are now in progress, and the selections of the best quality of steel for the purpose will be determined by testing a number of different barrels at the Springfield Armory. The plates accompanying Appendix 13 of this report give an interesting view of the form and dimensions of the barrels used in a number of existing small-caliber rifles.

SMALL-CALIBER RIFLE AMMUNITION.

The manufacture of the experimental .30-caliber rifle cartridge, adopted especially for the use of the Board on Magazine Small Arms, and described in my last annual report, has been continued at the Frankford Arsenal in sufficient quantity for experimental purposes. Some of the trial rifles presented to the board required the use of a cartridge without the rim or flanged head, having instead a cannelure or groove near the base of the case to provide a hold for the extractor, and a limited quantity of these grooved cartridge cases have also been manufactured. A report of tests made at Frankford Arsenal is appended. More recently, as reported by the commanding officer of the arsenal, a lot made for the Belgian Mauser magazine rifle has been used by the board, and regarded as equal to, if not better than, many received from other sources.

The grooved case has been introduced in several foreign services and has certain merits which adapt it to the particular guns in which it is used. The absence of the flange conduces to economy of space, particularly in the packages or clips which hold the magazine ammunition; the cartridges lie evenly in the packages and the feeding is facilitated. On the other hand, this case must be mainly supported against the blow of

the firing pin and the requisite nice adjustment of position in the chamber accomplished by the fit of the case against the forward slope or choke of the chamber, unless, as may be done in a particular gun, the extractor is utilized as a support for the cartridge. This is much less easy of accomplishment than with the flanged case, requiring closer and more difficult limits of manufacture, and the presence of any foreign substance or enlargement of the chamber in service operates against the utility of the cartridge on account of the closeness of fit required. With the flanged head the cartridge is well supported in proper position longitudinally and positive action is assured by the bearing of the flange on the square face of the counterbore provided for it.

The result of all our experiments has shown that the grooved cases are less serviceable than the flanged, and having a magazine rifle which can be adapted with equal facility to use either form of cartridge case, that with the flanged head must be preferred. The question as to which form of cartridge case shall be used in the magazine small arms for our service is for the present practically settled by the fact that the arm recommended by the Board on Magazine Arms is for a flanged-head cartridge, and that this arm has been adopted for the military service.

An exhaustive series of experiments relating to the use of lubricant and the manner in which it shall be applied if used, the best material for the jackets which cover the bullets, the material of the bullet proper, and the form of primer have been instituted at the Frankford Arsenal in connection with the manufacture of the small-caliber ammunition for service.

Smokeless powder for small arms.—Tests have been made of the various samples of smokeless powder for small arms which could be procured, and the principal reports thereon are appended. It had been hoped to secure a sample of the Navy smokeless powder of this class. Continued tests of the Wetteren powder have been made for velocities and pressures and to determine the effect of storage at arsenals, as well as remote posts presenting marked contrasts of climate, and these are still in progress. The influence of granulation has also been made the subject of investigation and report. The Troisdorf powder, of which a sample was procured and forwarded by Capt. Hein, United States military attaché at Vienna, from the "Rheinisch Westphälische Sprengstoff Geselschaft," has given the best results, and a lot of 100 pounds of that powder has been purchased for further tests. From the tests made of this powder it is deemed but slightly inferior to the best powders of this class heretofore tested by the Department. The two powders in this category, the Houghton and one of the forms of Maxim powder, are both by American inventors. The parties interested in each of these powders have announced their intention to establish manufactories for the powders, but the Department has been unable at this date to procure either kind in quantity.

In the matter of the pressure exerted by smokeless powder fired in small-caliber rifles careful investigations have been made and the full reports are appended. The results indicate that the pressure is less than has been heretofore supposed and have led to the adoption of the crusher form of gauge arranged in a housing secured to the side and communicating with the chamber through the wall of the barrel.

An officer of the Ordnance Department, Capt. Pitman, has been assigned to the special duty of organizing and conducting the chemical laboratory at Frankford Arsenal, and is now engaged in that work. In the preparation of plans he was indebted to suggestions made by Lieut. Willoughby Walke, Fifth United States Artillery, and to an inspection of the chemical laboratory at the artillery school, Fort Monroe, under the charge of that officer.

REVOLVERS.

A .38 caliber revolver has been adopted for the military service to replace the .45 caliber now in use, pursuant to the following correspondence:

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, D. C., April 19, 1892.

SIR: I have the honor to recommend the adoption of .38 caliber for the military service revolver, in place of .45 caliber, as now prescribed. This recommendation is based upon the favorable outcome of trials of .38 caliber revolvers which have been made during the past two years. After trial by a board of officers at the Springfield Armory, in 1889, two hundred of .38 caliber revolvers were procured and issued to troops in the field, where they were subjected to a crucial test. Certain minor defects only were developed. The reports of the company commanders who tested the arms in the field, and a revolver with the minor defects corrected, were some months ago submitted to another board at the Springfield Armory, and the arm is now perfected and ready for service.

The subject of the best caliber to adopt in connection with modern changes in small arms and the best results obtained in other countries in connection with the peculiar ballistic properties required for a revolver has during these years received careful study, and many experiments have been made. The results indicate and prove that the caliber .38 is the best for us to adopt.

Very respectfully,

D. W. FLAGLER,
Brig. Gen., Chief of Ordnance.

The SECRETARY OF WAR.

[First indorsement.]

WAR DEPARTMENT, *April 25, 1892.*

Approved.

S. B. ELKINS,
Secretary of War.

A contract has been made with the Colt's Patent Firearms Manufacturing Company, of Hartford, Conn., for five thousand of their improved double and single acting .38 caliber revolvers like the pattern finally passed upon by the Department, and these will be ready for issue during the current fiscal year. Ammunition for these revolvers

is now being made at the Frankford Arsenal. The principal dimensions, as compared with the .45 caliber Colt's, are as follows:

	.38 caliber.	.45 caliber.
Total length ..... inches..	11.30	12.50
Length of barrel	5.96	7.50
Diameter of bore	.362	.445
Chambers ..... number..	6	6
Length of cylinder ..... inches..	1.495	1.608
Diameter of cylinder ..... do....	1.45	1.65
Total weight ..... pounds..	2.016	2.31
Weight of powder charge ..... grains..	15 40	28
Weight of bullet ..... do....	150	230

Appendix 15 contains the report of the board of officers convened at the Springfield Armory to examine and test the revolvers received from the field, in connection with the reports of the company officers, and the supplementary report on the improved pattern revolver.

MEASURING AND INSPECTING INSTRUMENTS.

Comparators.—The modern ordnance now being made by the Department renders necessary exact measurements of lengths of considerable magnitude and the introduction of means for uniformly reproducing such measurements at the arsenals and other establishments where the guns and other stores are made. The preparation of comparators with standard bars to measure lengths up to 80 inches is now in progress. A shop comparator to be used at the gun factory is nearly completed, and will be followed by a standard comparator to be located at the Watertown Arsenal and used as well in the accurate investigations there made in connection with the testing machine as for the measurements of standard gauges for issue to other establishments. The standard comparator will be provided with a dividing engine attachment for graduating other bars as required. (See reports of May 5, 1890, published herewith, Appendix 48.)

The bars for both comparators will be graduated or investigated by the Coast Survey Office, through the courtesy of the Superintendent of the Survey, for comparison with United States standard. The 70-inch bar of the shop comparator is now being graduated at that office. The bar was made at the Watertown Arsenal, under the direction of James E. Howard, and is a fine specimen of workmanship. It is made of steel, carefully annealed, and has a cross-section of H form, which provides for placing the graduation lines upon the neutral axis of figure, and is deemed in this respect fairly comparable with the X form adopted for the international standard meter. An inlaid platinum strip and plugs placed at intervals of 1 inch are provided to receive the graduation lines. The shop comparator, provided with this bar and a micrometer microscope with a least reading equal to $\frac{1}{10000}$ of an inch, will be deemed capable of defining measurements with sufficient accuracy for all shop purposes at the gun factory, or within a limit of about $\frac{1}{5000}$ of an inch.

The general design and description of the shop comparator is published in the report of the board on inspecting instruments, Appendix 50, herewith.

Diameter calipers.—Several patterns of these have been made to include measurements of diameters up to 70 inches, as described in the appendices. All are provided with micrometer attachments reading to $\frac{1}{1000}$ of an inch. The calipers for exterior diameters consist of bows or frames (metal or wood) of varying size, carrying a set of the micrometer points for common use. The calipers for interior diameters are extension rods in which the extension handles are made of wood in preference to gutta-percha, as formerly used. The wood-frame calipers evince even greater stiffness than the steel, wood-lagged arms, and are superior to them in regard to weight, ease of manipulation, and cost. The inconvenience attending their tendency to warp is obviated by means of the socket joints with which they are provided to carry the measuring points. Excellent results have attended the making and trial of an aluminium caliper arm, which is the latest form tested. The calipers of light weight may be manipulated by hand. With the heavier forms means of suspension are required, which necessitate an automatic balance for the weight and ready means of moving the caliper freely along the piece under measurement. Apparatus for this purpose is described in the reports of the commanding officer of Watertown Arsenal and the board on inspecting instruments. In both of these the weight of the caliper is supported by a spring. A method of suspension by cords and pulleys with balancing weights has been introduced to overcome the objections to the suspension spring, as described in my report of May 5, 1890, published herewith, and as a method which may be readily and cheaply improvised for use when more elaborate means are lacking.

Star gauge and accessories.—The principal recent improvements in the star gauge, which have been applied by altering some of those in use, consist in substituting a micrometer reading handle for the sliding vernier handle and making the head to revolve about the staff for gauging the rifling grooves of guns. New star gauges to be hereafter made will be substantially as described in the report of the board on inspecting instruments, herewith.

In gauging the very long bores of the guns now made, the star gauge staff requires to be carefully centered and supported both within and without the bore. The interior rests for the staff now in use, as described by the board on inspecting instruments, are not entirely satisfactory. The wooden exterior rest may be improvised if necessary. The requirements of the work will probably be fully met by the exterior and interior rests described in my report of July 11, 1887, herewith, sets of which are now being made for issue and trial.

The board on inspecting instruments was also charged with the preparation of instructions to inspectors in the manufacture of cannon and

of preparing forms for blanks and books of record. Their report on these matters has been published in small pamphlet form for the use of inspectors.

MINOR CHANGES IN MATERIAL.

A nosebag with improved ventilator.—A perforated piece of leather sewed to the front, and with additional holes pierced in the side straps, as suggested by Capt. J. C. Ayres, Ordnance Department, is now made the pattern for future issues to the cavalry.

A link with a hook instead of a buckle was suggested by Capt. H. M. Kendall, Sixth Cavalry, and has replaced the one formerly used.

A strap with a hook intending to take the place of the thong heretofore used for holding together the coils of the lariat as proposed by Sergt. Edward Suschanke, of Troop B, Fifth Cavalry, has been tried and reported upon favorably, and directions have been given to manufacture it for future issue.

The saddle cloth for officers has had its dimensions increased about two inches in length and width, on account of reports received that the cloths as originally made do not entirely cover the blanket.

The Department has under consideration the substitution of a lighter and milder bit for the one now issued to the cavalry. Samples have been issued for trial which have met with sufficient approval to warrant the belief that a much more satisfactory bit than the one now in use can be soon supplied.

ARTILLERY.

Carriages.—The reports of the practice marches made by the different battery commanders have led to several minor changes in the construction of the parts of the caisson, and of the stores issued.

Canvas watering buckets have been substituted for the galvanized iron watering buckets heretofore used.

The paulins are made 12 by 12 feet instead of 11 by 11 feet.

The backs of the ammunition chests were found to be too weak, and several of them were reported as injured in limbering up. These backs are now made of oak instead of whitewood, and a larger corrugated iron plate is fastened to the backs of the limber chests. The iron stays on the front and rear of the ammunition chests were assembled partly by rivets and partly by screws. The screws soon lost their hold in the wood, and these stays are now riveted throughout. The braces for supporting the lid of the ammunition chest were too light, and they are now made of a heavier pattern.

The large nut at the outside ends of the nave box unscrewed at times and jammed the wheels. This nut is now prevented from unscrewing by being splined to the box.

The linch washers as issued rotated with the wheel at times, and by wearing the head of the rivet which connects the guard to the linch-pin allowed the guard to gradually wear loose and sometimes fall off.

This has been obviated by fixing a stud to the washer, which keeps it from revolving with the wheel.

The device for retaining the spare poles in position was inadequate and allowed the poles to drop from place. A more suitable arrangement has been devised.

The arrangement for holding up the pole prop was found unsuitable, as the spring intended to maintain the hook in position broke and the pole prop fell to the ground. A strap has been arranged to take the place of the hook.

The bolster which supports the spare wheel axle is held in place by two bolts. The nut on the front bolt frequently jarred loose, and fell to the ground, leaving the whole weight of the spare wheel to be supported by the rear bolt. This has been corrected by burring up the head of the front bolt after the nut is put in place.

The pole wore rapidly by coming in contact with the driver's stirrup, so rapidly as to soon become unserviceable. This has been corrected by covering the pole at this place with sheet copper.

The rubber pads at the end of the neck yoke were held in place by screws which would fall out. This method of fastening has been improved.

The handles of the ammunition chest were found to be too low to protect the elbow of the rider from the wheel. With a view of obviating this difficulty they have been made longer.

The lantern as issued was found to be not sufficiently strong, and a more suitable lantern is now being experimented with.

The martingale for the wheel horses was connected to the neck yoke by a strap furnished with a buckle. The tongue of the buckle cut the strap, and even when a double buckle was used it was found unsatisfactory. Capt. J. M. Lancaster, Light Battery C, Third Artillery, substituted for the strap with buckle a cincha strap. Martingales furnished with the cincha were supplied for trial to several of the batteries, and the reports have generally favored the substitution of these martingales for those formerly used. The tests at Rock Island Arsenal showed that the strap with the double-tongued buckle required the application of about 850 pounds to break it; the cincha strap required 2,200 pounds to break it. Directions have been given to supply the martingale with cincha in the subsequent manufactures.

The hook for the stirrup strap was found to be too light, and has been replaced by a buckle.

Mountain guns.—Capt. Allyn Capron, First Artillery, after considerable experience in the field, suggested several modifications in the packing outfit for the Hotchkiss mountain gun. These modifications are shown in the descriptions and drawings published in an appendix to this report. It should be noted that a variation from the model carriage originally made renders it impracticable to use the modified pack saddle with carriages which have been modified. The angle irons at

the bottom of the body of the carriage have been prolonged to the axle seat, on both sides in some cases, and in others on one side only. In both cases, however, they extend further than on the model carriage, and prevent the carriage from falling into place in the saddle. Such carriages will have to be sent to Rock Island Arsenal for alteration.

INFANTRY.

At the suggestion of Capt. H. O. S. Heistand, Eleventh Infantry, and on the recommendation of the Major-General Commanding the Army, a sword with a whistle has been made for experimental purposes and issued for trial.

I have also the honor to submit herewith the following papers as appendices to this report:

Appendix 1.—Statement of principal articles procured by fabrication during the year ended June 30, 1892.

Appendix 2.—Statement of principal articles procured by purchase during the year ended June 30, 1892.

Appendix 3.—Statement of ordnance, ordnance stores, etc., issued to the Military Establishment, including the national homes for soldiers of the volunteer and regular Army and exclusive of the militia, during the year ended June 30, 1892.

Appendix 4.—Statement of ordnance, ordnance stores, etc., distributed to the militia from July 1, 1891, to June 30, 1892, under section 1667, Revised Statutes.

Appendix 5.—Statement of ordnance, ordnance stores, etc., distributed to the colleges from July 1, 1891, to June 30, 1892, under section 1225, Revised Statutes.

Appendix 6.—Statement of arms and ammunition issued to the Executive Departments during the year ended June 30, 1892, under the provisions of the act of March 3, 1879.

Appendix 7.—Report of action taken during the year ended June 30, 1892, under the provisions of the act approved March 3, 1881.

Appendix 8.—Showing the stations and duties of the officers of the Ordnance Department.

Appendix 9.—Report of the board of officers to select magazine arms or the United States military service (22 plates).

Appendix 10.—Report on sights and bayonets for small arms (5 plates).

Appendix 11.—Report of principal operations of Columbia Arsenal.

Appendix 12.—Annual report of chief ordnance officer Department of the Platte.

REPORTS FROM SPRINGFIELD ARMORY.

Appendix 13.—Small-caliber rifle barrels (4 plates).

Appendix 14.—Trials of smokeless powders (Reports Nos. 1 to 4).

Appendix 15.—Trials of Colt's and Smith & Wesson .38 caliber revolvers.

REPORTS FROM FRANKFORD ARSENAL.

Appendix 16.—The effect of granulation upon velocities and pressures of Wetteren smokeless powder (2 plates).

Appendix 17.—Trials of caliber .30 ammunition with grooved-head cartridge case.

REPORTS FROM WATERVLIET ARSENAL AND ARMY GUN FACTORY.

Appendix 18.—Report of principal operations (7 plates).

Appendix 19.—Specifications for steam-power plant.

Appendix 20.—Specifications for appliances for transmission of power.

Appendix 21.—Specifications for belting.

Appendix 22.—Specifications for locomotive engine and platform.

Appendix 23.—Specifications for granite-block road and pavements.

Appendix 24.—Specifications for heating plant.

REPORTS FROM ROCK ISLAND ARSENAL.

Appendix 25.—Report of principal operations.

Appendix 26.—Report on development of water power (20 plates).

Appendix 27.—Modified packing outfit for Hotchkiss 1.65-inch mountain gun (6 plates).

REPORTS FROM WATERTOWN ARSENAL.

Appendix 28.—Report of principal operations.

REPORTS FROM ORDNANCE PROVING GROUND.

Appendix 29.—Report of principal operations (6 plates).

Appendix 30.—Specifications for erection of new frame office building.

Appendix 31.—Effect of position of vent upon velocities and pressures with 3.2-inch field guns, steel.

Appendix 32.—Trials of equipment, platform, etc., for 3.6-inch B. L. field mortar, steel (4 plates).

Appendix 33.—Tests of Merriam's base percussion fuse (1 plate).

CONSTRUCTION OF ORDNANCE.

Appendix 34.—Progress report on manufacture of steel forgings, etc., at the Bethlehem Iron Works, South Bethlehem, Pa.

Appendix 35.—Progress report of manufacture of steel forgings, etc., at the Midvale Steel Works, Philadelphia, Pa.

Appendix 36.—Progress report of manufacture of mortars and mortar carriages at the Builders' Iron Foundry, Providence, R. I. (7 plates).

Appendix 37.—Progress report on the manufacture of ordnance at the West Point Foundry, Cold Spring, N. Y. (7 plates).

Appendix 38.—Design for a 7-inch B. L. siege mortar, steel (2 plates).

REPORTS OF BOARD FOR TESTING RIFLED CANNON, ETC.

Appendix 39.—Test of 12-inch B. L. mortar, cast iron, hooped with steel, No. 1 type.

Appendix 40.—Test of 3.6-inch B. L. rifle, steel, No. 1 type (10 plates).

Appendix 41.—Progress report of test of Hotchkiss 3-inch B. L. mountain rifle, type (8 plates).

Appendix 42.—Test of 10-inch B. L. rifle, cast iron, wire-wrapped (3 plates).

REPORTS OF ORDNANCE BOARD.

Appendix 43.—Test of Easton & Anderson 12-inch spring-return mortar carriage (4 plates).

MISCELLANEOUS.

Appendix 44.—Frankford Arsenal combination fuse, model 1891; effects of weather and temperature; graduation of fuse for service (1 plate).

Appendix 45.—Cutter and crusher gauges for small arms, and pressures of smokeless powders (1 plate).

Appendix 46.—The Frankford Arsenal 3.2-inch shrapnel; description and report of firing test (6 plates).

Appendix 47.—Specifications and drawings of the Hotchkiss and the American Projectile Company 3.2-inch shrapnel (2 plates).

Appendix 48.—Measuring and inspecting instruments (4 plates).

Appendix 49.—Wood-frame calipers and appurtenances for measuring exterior diameters (4 plates).

Appendix 50.—Report of Board on Inspecting Instruments (19 plates).

Appendix 51.—Report on small-arm targets, by Lieut. Col. D. W. Flagler, Ordnance Department.

I have the honor to be, very respectfully,

D. W. FLAGLER,
Brig. Gen., Chief of Ordnance.

The SECRETARY OF WAR.

APPENDIX 1.

Statement of principal articles procured by fabrication at the arsenals during the fiscal year ended June 30, 1892.

CLASS I.

1 3.2-inch steel rifle, Gerdom breech mechanism.
1 3.2-inch steel rifle, Driggs-Schroeder breech mechanism.
12 8-inch breech-loading rifles.
25 3.2-inch breech-loading steel rifles.

CLASS II.

5 3.6-inch carriages for breech-loading steel field mortars.
44 3.2-inch carriages, metallic.
1 7-inch carriage, metallic, for breech-loading howitzer.
25 3.2-inch caissons and limbers.
25 3.2-inch limbers for field carriages.
6 combined forges and battery wagons.
8 15-inch carriages and chassis.

CLASS III.

46 breech sights for 8-inch rifles.
37 breech sights for 3.2-inch rifles.
1 breech cover, 8-inch rifle.
1 breech cover, 10-inch rifle.
1 breech cover, 12-inch rifle.
1 breech cover, 12-inch mortar.
1 gun sight, clinometer.
28 breech covers, 3.2-inch rifles.
1 breech cover, 3.6-inch rifle.
71 breech straps, 3.2-inch rifles.
262 buckets, watering.
119 bow-spring brakes, 3.2-inch carriages.
25 chocks.
4 carrying bars.
15 elevating bars.
1 fuse cutter.
4 fuse-plug wrenches.
26 gunners' reamers.
20 gunners' haversacks.
4 gun covers.
135 handspikes, maneuvering.

40 handspikes, rear.
22 handspikes, trail.
2 handbarrows.
60 sets harness for two wheel horses.
80 sets harness for two lead horses.
10 sets harness for Hotchkiss mountain guns.
200 harness sacks.
1 loading pan for 12-inch rifle.
152 lanyards.
100 muzzle covers and straps.
13 muzzle sights, 8-inch rifle.
37 muzzle sights, 3.2-inch rifle.
1 pointing scale.
35 pinch bars.
3 powder sieves.
22 powder funnels.
2 tompions, 6-pounder gun.
1 tompion, 10-inch rifle.
1 tompion, 12-inch rifle.
1 tompion, 12-inch mortar.
2 tompions, 3-inch rifle.
51 tompions, 3.2-inch rifle.
1 tompion, 4½-inch rifle.
3 tompions, 8-inch rifle.
9 tompions, 15-inch gun.
14 combined tompions and muzzle covers, 3.2-inch rifle.
1 combined tompion and muzzle cover, 3.6-inch rifle.
14 tube pouches.
4 water tubs.
32 vent covers.
25 vent punches.
1 vent piece.
40 wipers for mortars.
1 set tools for dismounting and assembling breech mechanism, 12-inch breech-loading mortar.
20 sets tools for dismounting breech mechanism of 8-inch rifle.
4 wiping rods, Hotchkiss revolving cannon.
40 wheel chocks, 8-inch.
3 paulins, 20 by 20 feet.
300 paulins, 12 by 12 feet.
22 feed guides, Gatling guns.
2 hoppers, Gatling guns.
22 powder measures.
62 prolonges.
21 priming wires.
28 primer pouches.
38 sight pouches.
14 pass-boxes, metallic.
5 plummets for mortars.
25 props for sponges and rammers.
10 rammers and staves, 8-inch rifle.
46 shell-hooks.
300 securing stakes.
10 scrapers for cannon.
2 shot-carrying bars.
100 sponge covers, 12-pounder gun.

6 sponge covers, 3.2-inch rifle.
80 sponge covers, 3.2-inch rifle (bore).
107 sponge covers, 3.2-inch rifle (chamber).
54 sponge covers, 6-pounder gun.
36 sponges and rammers, 3.2-inch rifle, jointed.
108 sponges and rammers, 3.2-inch rifle, short, combined.
4 sponges and rammers, 6-pounder gun.
202 sponges and rammers, 3-inch rifle.
107 sponges and rammers, 8-inch rifle.
50 sponges and staves, Hotchkiss mountain gun.
16 sponges and staves, 8-inch rifle (chamber).
4 sponges and staves, 8-inch rifle (bore).
60 sponges and staves, 7-inch siege howitzer.
30 sponges and staves, 5-inch rifle (chamber).
30 sponges and staves, 5-inch rifle (bore).

CLASS IV.

292 12-inch mortar shell.
118 8-inch mortar shell (800 pounds).
25 8-inch shell for experiments with high explosives.
5,792 3.2-inch shell, long.
1,805 3.6-inch shell, long.
200 3.6-inch mortar shell, long.
1,035 7-inch shell, for breech-loading siege howitzer.
74 10-inch solid shot, 575 pounds.
265 10-inch solid shot, 575 pounds, for Crozier and Woodbridge guns.
275 12-inch solid shot, 1,000 pounds.
625 5-inch shell for siege guns.
92 7-inch shell for high explosives.
175 8-inch solid shot.
12 3.2-inch shrapnel, experimental.

CLASS VI.

1,500 Springfield cadet rifles, model 1884.
26,200 Springfield rod-bayonet rifles, model 1888.
6 Springfield rifles, caliber .30.
1,000 officers' swords.

CLASS VII.

CAVALRY EQUIPMENTS.

1,000 carbine sling swivels.
105 carbine scabbards.
2,000 canteen straps.
4,000 saber knots.
3,010 pistol holsters.
2,000 saber belts.

INFANTRY EQUIPMENTS.

7,636 bayonet scabbards.
6,500 bayonet-scabbard bodies.

5,387	blanket bags.
5,075½	pairs blanket-bag shoulder straps.
3,650	pairs blanket-bag coat straps.
10,229	cartridge boxes, McKeever pattern, 1874.
5,002	waist belts.
5,000	waist-belt plates.
674	cartridge-belt plates.
7,448	canteens.
8,000	canteen straps.
500	frogs, sliding.
11,152	gun slings.
7,160	haversacks.
8,150	haversack straps.
488	knives.
488	forks.

APPENDAGES.

29,601	headless shell extractors.
36,450	screw-drivers.
8,650	wooden wiping rods.

HORSE EQUIPMENTS.

602	bits, curb, cavalry.
4,687	bridles, curb, cavalry.
4,340	halters and straps.
1,002	horse covers.
5,000	lariats.
6,000	links.
2,941	nosebags.
1,891	saddles, cavalry.
1,000	saddle bags, canvas.
1	guidon socket.
3	housings for general officers' saddles.
1	housing for major-general's saddle.
3	housings for brigadier-generals' saddles.
3,000	carbine boots and straps.
7,500	pairs spurs.
940	pairs spur straps.
92	saddle cloths, line officers'.
36	saddle cloths, staff officers'.
53	saddle cloths, dyed duck.

CLASS VIII.

8,410	blank cartridges, 3.2-inch rifle.
30,397	blank cartridges, 3-inch rifle.
21,380	blank cartridges, 12-pounder gun.
9,925	blank cartridges, 6-pounder gun.
1,115	blank cartridges, 12-pounder mountain howitzer.
2,525,893	rifle ball cartridges, caliber .45.
1,505,740	rifle and carbine blank cartridges, caliber .45.
35,810	rifle ball cartridges, caliber, .30.
330	rifle ball cartridges (dummy), caliber .30.
1,761,062	carbine ball cartridges, caliber .45.

503,412 revolver ball cartridges, caliber .45.
507,480 revolver blank cartridges, caliber .45.
42 fuses, combination, 3.2-inch.
100 fuses, percussion, 3.2-inch.
2,508,000 carbine bullets, caliber .45, 405 grains.
2,198,000 rifle bullets, caliber .45, 500 grains.
10,263 rifle bullets, caliber .30.
5,150 pounds balls, 3.2-inch shrapnel.
500,000 revolver bullets, caliber .45.
200 shot-gun cartridges, No. 20.
126,450 friction primers for cannon.
4,000 electric primers for cannon.
1,020 electric primers, obturators.
6,540 friction primers, obturators.

CLASS IX.

698 blocks.
72 half-blocks.
72 quarter-blocks.
6 blocks, wood, single.
6 blocks, wood, double.
8 capstans.
17 capstan bars.
92 chocks, roller.
52 chocks, wheel.
8 cradles, gun.
2 gin slings.
2 handcarts.
24 handspikes, gin.
72 rollers, long.
171 rollers, short.
35 shifting planks.
84 skids.
5 sling chains.
3 sling carts, large.
44 way planks.
10 platforms for mortars.
6 platforms for siege carriages.
6 gin falls.
25 sets marking outfits.
8,300 marksman's buttons.
4 gins, Piper, complete.
3 levers with adjustable fulcrum and blocks.
1 shear fall with blocks.
3 garrison gins.
1,000 sharpshooters' badges.
752 gunners' badges.
1 travois.
35 cranes, loading.
2 slings for cannon.
1 bail for 10-inch gun.
20 hoisting pulleys.
1 bell shelter tent.
10 sets bench reloading tools.
35 priming tools.
50 primer-inserting tools.

10 rings.
10 links.
20 link pins.
20 nuts, cartridge-head adjusting screw.
30 screws, cartridge head.
5 stands.
245 dies, various.
10 springs, check lever.
10 check levers.
25 powder-charging tools.
20 assembling and crimping tools.
997 parts reloading tools.
15 marking staves and disks.
50 sets marking rods, disks, and brushes.
10,576,000 pasters.
298 signal flags.
519 streamers for rifle range.
2 targets, Cushing.
5 targets, Texas.
166 targets, revolving, Laidley.
25,000 targets, paper.
17 targets, iron, gallery practice, 100 yards' range.
24 targets, floating.
16 targets, towing.
28 targets, land.

CLASS X.

3 brass bushing rings for elevating trunnion hoops, 10-inch rifles.
2 bronze handles, 3.2-inch rifles.
4 screws for handles, 3.2-inch rifle.
2 vent bushings, 3.2-inch rifles.
1 rear-sight socket, 3.2-inch rifle.
1 rear-sight socket screw, 3.2-inch rifle.
1 crank-shaft pinion for breechblock rotating gear, 12-inch rifle, No. 1.
1 new crank arm with additional handle, modified teeth, and arm.
5 obturating pads.
5 gas-check pads.
11 pipe handles for rotating gear, 12-inch.
1 pair pinions for breech mechanism, 12-inch.
2 sets pinions for 12-inch type gun, No. 1.
1 spring lock for 12-inch type gun, No. 1.
16 automatic vent closers, 3.2-inch.
14 ammunition chests.
111 parts siege carriages.
344 parts field carriages.
38 poles for field and siege carriages.
2 bolts.
2 sets floor boards, 15-inch carriage.
81 retraction ropes.
14 parts mortar beds.
8 chin bolts for cap square.
136 parts ammunition chests.

4 pairs road brakes, 3.2-inch caisson and limber.
1 pair road brakes, combination forge and battery wagon.
1 cap square, light 12-pounder carriage.
12 double and single trees, 3.2-inch carriages.
39 parts caissons and limbers.
62 linchpins, etc., 3.2-inch caisson and limbers.
1 stay pin, key, and chain, 12-pounder gun.
2 sets pole irons, 3.2-inch carriages.
1 pintle fork, 3.6-inch steel mortar carriage.
12 wheels, Hotchkiss mountain gun.
10 bridles, near horse.
10 bridles, off horse.
20 curb straps.
5,108 buckles, brass, $\frac{3}{4}$-inch.
4,445 buckles, bar, iron, $\frac{5}{8}$-inch.
5,555 buckles, bar, brass, $\frac{5}{8}$-inch.
14 breast straps.
8 brow bands.
42 parts collars.
6 halters, artillery.
50 halter straps.
7 hair girths.
8 hooks for side straps.
38 martingales.
1 neck yoke.
4 rubber neck-yoke pads.
16 pole pads.
11 pole props.
43 poles, complete.
209 parts artillery harness.
12 traces.
12 surcingles.
32 trace ropes.
8 sets trestles for mortars.
25 rammer heads, 3.2-inch rifles.
38 sponge heads (bore and chamber), 3.2-inch rifles.
100 sponge heads, 15-inch gun.
68 sponges, 3-inch rifles.
30 sponges (bore), 3.2 inch rifles.
32 sponges (chamber), 3.2-inch rifles.
30 sponges, 8-inch rifles.
18 sponges, $4\frac{1}{2}$-inch seige guns.
122 sponges, 12-pounder guns.
4 sponges, 6-pounder guns.
50 sponges, Hotchkiss mountain guns.
20 sponges, 10-inch smoothbore guns.
10 staves, 3-inch rifles.
775 base plugs, 5-inch shell.
250 copper bands, 5-inch shell.
100 copper bands, 7-inch shell.
100 copper bands, 10-inch shell.
83 sabots.
75 tin straps for sabots.
1 adjusting screw, breech sight, Hotchkiss mountain gun.
295 stocks, model 1884, complete.
1,821 stocks (wood part).

93 stocks, assembled.
9 stocks, Springfield shotguns.
141 tips.
71 tip screws.
156 ramrod stops.
18 band stacking swivels.
31 band springs.
18 band swivel pins.
212 side-screw washers.
1 butt plate.
149 butt-plate screws.
2 butt-plate covers.
3 cover springs.
5 cover-spring screws.
12 cover-stud pins.
5 cover-friction springs.
133 guards, complete.
46 guard plates.
42 guard bows.
299 guard screws.
217 guard-bow swivels.
267 guard-bow swivel screws.
18 guard-bow nuts.
140 leaf-slide binding screws.
10 leaf-slide stop pins.
145 triggers.
217 trigger screws.
1,182 rear-sight bases.
1,066 rear-sight bases, complete.
1,162 rear-sight screws, front and rear.
1 rear-sight leaf, complete.
37 rear-sight leaves.
10 rear-sight joint pins.
35 barrels, rifle, caliber .30.
380 barrels.
50 receivers.
3,484 extractors
27 extractors, Springfield shotgun.
329 hinge pins.
37 hinge-pin studs.
1,425 ejector springs.
1,693 ejector-spring spindles.
106 ejector studs.
130 cam latches.
2 cam latches, complete.
1,031 cam-latch springs.
43 breechblocks.
37 breechblock caps.
298 breechblock-cap screws.
26 breechblocks, complete.
54 breech screws.
7,721 firing pins.
1,316 firing-pin screws.
1,394 front sights..
302 front-sight covers.
528 front-sight cover pins.

1,086 front-sight pins.
757 tang screws.
56 thumb pieces.
756 bands, upper.
397 bands, lower.
130 locks, complete.
170 lock plates.
175 mainsprings.
557 mainspring swivels.
306 mainspring-swivel rivets.
280 hammers.
60 rod-bayonet heads.
1,143 tumblers.
339 tumblers, swiveled.
1,432 tumbler screws.
266 bridles.
640 bridle screws.
1,015 sears.
649 sear screws.
191 sear springs.
192 sear-spring screws.
1,030 side screws.
36 ramrods.
42 ramrods, jointed.
73 bayonet clasps.
461 bayonet-clasp screws.
69 bayonet-clasp stop screws.
1,806 sight protector bands.
27 swivels.
27 swivel rings.
15 movable base springs.
164 windage screws.
49 windage-screw heads.
49 windage-screw head pins.
9 parts officers' swords.
3 parts officers' sabers.
200 broadsword blades, wood.
50 broadsword guards, iron.
1,250 hook attachments.
2,002 bits, curb, cavalry.
1,000 bits, watering.
1,500 curb straps.
1,000 girth straps.
3,000 halter straps.
5,000 hook straps.
150 hooks for blanket bags.
2,000 back straps, front and rear.
50 straps for lariats and picket pins.
48 ovals, guard plates.
3,000 rings, brass, $\frac{7}{8}$-inch.
7,000 rings, iron, $2\frac{1}{2}$ inch.
20,000 staples for rings.
582 pairs stirrup straps.
560 pairs stirrups, hooded.
6,000 coat straps for saddles.
20 cartridge bags, $4\frac{1}{2}$ inch rifle.

10,300 cartridge bags, 3.2-inch rifle.
26,682 cartridge bags, 3-inch rifle.
1,155 cartridge bags, 3.6-inch rifle.
70 cartridge bags, 3.6-inch field mortar.
129 cartridge bags, 5-inch rifle.
66 cartridge bags, 7-inch breech-loading howitzer.
6 cartridge bags, 8-inch rifle.
145 cartridge bags, 12-inch rifle.
3 cartridge bags, 12-inch mortar.
26,288 cartridge bags, 6-pounder gun.
23,160 cartridge bags, 12-pounder gun.
466 cartridge bags, 15-inch gun.
300 cartridge bags, 24-pounder gun.
1,550 cartridge bags, 10-inch rifle.
450 cartridge bags, 8-inch rifle.
180 cartridge bags, 3-inch Hotchkiss mountain gun.
2,609,300 cartridge primers.
50,100 cartridge shells, rifle and carbine.
30,584 cartridge shells, Springfield shotgun, No. 20.
7,800 cartridge shells, rifle, caliber .30.
20,000 cartridge shells, revolver, caliber .45.
60 point plugs for shrapnel.
6,209 parts of targets.
1,949 parts Laidley revolving target.
307,995 paper silhouettes.
3,000 cloth silhouettes.
272 silver bars for sharpshooters' badges.
4 wire-rope sheaves.
3 shoes for garrison gin.
3 shoes for Piper gin.
2 journal boxes for casemate gins.
1 casting for iron pipes for Gerdom carriage platforms.
126 bolts and washers, various.

TOOLS AND MISCELLANEOUS.

1,465 arm chests.
2,804 boxes, packing.
22 boxes for small-arms ammunition.
400 metallic powder barrels.
102 tin cans.
109 crates, packing.
100 boxes cleaning material.
500 oak boards.
1 cage for exploding shells.
10 anchors.
3 anchor chains.
3 arbors.
179 aprons, smiths'.
100 augers, armorers'.
572 brushes.
108 bits, assorted.
100 boxes blacking for leather.
1 caliper.
36 countersinks.
118 counterbores.

135 chisels, various.
79 cutters, assorted.
6 crowbars.
104 chamois-skin cases, for swords.
609 dies, various.
1,017 drills.
2 funnels.
1,516 files, assorted.
182 files, rotary.
3 flatters.
1 set tools, pressure-gauge seat.
1 templet, 3.2-inch rifle, rear-sight shank.
34 gauges.
500 gas-checks.
1 set chamber gauges.
100 rubber rings, pressure gauge.
14 caliper arms.
4 ring gauges.
1 plug gauge.
1 set clamp straight-edges.
3,200 cylinders, pressure gauge.
1,300 gas checks, pressure gauge.
150 washers, pressure gauge.
20 springs, pressure gauge.
5 ring gauges, for setting star gauge.
22 pressure gauges.
2 parts star gauge.
705 parts pressure gauge.
7 hammers.
3 handbarrows.
6 horses, saddlers'.
100 hoof hooks.
32 handles, assorted.
6 sets post harness.
15 parts post harness.
20 holdfasts, iron.
1 heliograph.
2 gigs, filing.
90 gallons lacker.
4 sets measuring points, star gauge.
16 mauls.
1 cone grooving machine.
1 train drawing machine.
2 micrometers.
1,618 mills, armorers'.
32 mandrels.
2,800 pounds harness oil.
27 oilers.
5 oil cans.
33 punches, assorted.
678 pounds black paint.
1,798 pounds olive paint.
430 pounds paint.
10 pounds putty.
4 pots, various.
3 impression instruments.

20 portable arm racks.
3 parts arm racks.
229 reamers.
1 rifle guide, star gauge.
1 ring gauge for testing thread, 8-inch gun work.
1 plug gauge for testing thread, 8-inch gun work.
2 pairs magazine slippers.
3 sets stamps, figures.
3 sets stamps, letters.
19 stamps, seal.
5 stencil plates.
25 boxes stencil paste.
5 pounds solder.
1 star gauge, complete.
32 sets stencil outfits.
35 screw-drivers, crosshead caps.
169 taps, various.
12 tool chests.
53 tools, various.
8 thickness gauges.
1 thread gauge, combination fuses.
12 tongs for holding iron.
2 templets.
50 pounds black wax.
158 wrenches.
50 washers.
8 wheel-grease cans.
2 wheelbarrows.
63 wheel-grease can knives.
8 journal boxes, fixed and sliding.
100 empty boxes for cleaning materials.
12 cast-iron tablets for national cemetery.
1 elevator.
1 comparator bar.
600 pieces copper for pressure gauges.

APPENDIX 2.

Statement of principal articles procured by purchase during the year ended June 30, 1892.

CLASS I.

24 12-inch breech-loading rifled mortars.
1 4.7-inch Armstrong rapid-fire gun and accessories.
1 3-pounder Hotchkiss rapid-fire gun.
8 42 millimeter Hotchkiss mountain guns.
18 Gatling guns, model 1890.
21 cast-iron bodies for 12-inch breech-loading rifled mortars.

CLASS II.

8 steel carriages for Hotchkiss 42 millimeter mountain guns.
1 Granby return carriage.

CLASS III.

40 baskets for mortar implements.
145 artillery collars, cork-faced.
496 3-inch sponges for solid head.
515 3.2-inch sponges for solid head.
250 3.6-inch sponges for solid head.
265 4½-inch sponges for solid head.
496 12-pounder sponges for solid head.
250 5-inch sponges for spring leaf.
246 7-inch sponges for spring leaf.
501 8-inch sponges for spring leaf.
507 10-inch sponges for spring leaf.
250 12-inch sponges for spring leaf.
496 15-inch sponges for spring leaf.
24 plummets.
216 implements for Gatling gun, caliber .45.
8 sets, accessories, and spare parts, Hotchkiss 42-millimeter mountain gun.
40 accessories and spare parts, Hotchkiss 42-millimeter mountain gun.
40 accessories and spare parts, Hotchkiss 37-millimeter mountain gun.
13 globe lanterns.

CLASS IV.

7,000	rounds ammunition, Hotchkiss revolving cannon, caliber 1.50-inch.
500	rounds ammunition, Armstrong 4.7-inch rapid-fire gun.
44	3.2-inch Hotchkiss shrapnel.
4	ærial subaquatic projectiles, complete.

CLASS VI.

1	Austrian cavalry carbine, caliber .25.
1	German steel lance.

CLASS VII.

2,925	artillery saddle blankets.
6,139	cavalry saddle blankets.

CLASS VIII.

600,000	rifle ball cartridges, caliber .50.
20,000	rifle blank cartridges, caliber .50.
1,000	cartridges for Austrian cavalry carbine, caliber .25.
1,200	cartridges for German rifle, caliber .311.
2,128	cartridges for Parker breech-loading shotgun.
10,100	pounds cannon powder.
93,521	pounds brown prismatic powder.
81,010	pounds small-arms powder.
90,400	pounds sphero-hexagonal powder.
730	pounds powder for rapid-fire guns.
100	pounds blasting powder.
129,900	pounds mortar powder.
2	pounds smokeless powder.
45,000	pounds powder for field guns.
580	pounds emmensite.
16,706$\frac{5}{8}$	pounds dynamite.
5,045	pounds shot.
8,174	fuses.
502,600	gun wads.
100	feet safety fuse.

CLASS IX.

4	differential pulley blocks.
3	single blocks.
3	double blocks.
2	triple blocks.
4	tackle blocks.
7	sheaves for blocks.
8	hydraulic jacks.
1	Lewis range finder.
20	time internal recorder.
9	magnetic firing machines.
14	jackscrews.
5	sling chains.
1	telescope and tripod.

1	telescopic sight for 3.2-inch rifle.
1	traveling crane, 80 tons.
352	marksman's medals.
120	parts marksman's medals.
1	hoisting block.
17	parts of hoisting derrick.

CLASS X.

20	gas checks for 5-inch siege gun.
82	parts Gatling guns, model 1883.
1	steel axle for 7-inch howitzer carriage.
4,699	parts Colt's revolvers, caliber .45.
122	parts shotguns.
192	Archibald wheels for artillery carriages.
786	pounds pintle tongues for 12-inch carriages.
270	pairs Mogul springs, draft.
26,598	gunstocks, rough.
10,263	staves for stirrups.
65	pounds escutcheon pins.
2,880	escutcheon pins.
60	pocket compasses.
20	prismatic compasses.
188	singletrees.
95	doubletrees.
50	rubber buffers.
23,867	harness buckles.
15	halter bolts.
4,624	halter squares.
16,656	iron rings.
2,274	iron snaps.
56	forage-cap badges.
29	ornaments for horse furniture.
300	copper bands for 3-inch Hotchkiss shell.
166	yards gold lace.
20	hubs for Hotchkiss light 37-millimeter field carriages.
750	steel balls for 12-inch breech mechanism.
1,207	pounds steel cylinders, with plugs, for experiments with high explosives.
500	unfilled cartridge cases for Austrian cavalry carbine, caliber .25.
50	unfilled cartridge cases for German rifle, caliber .311.
1	pair bevel gears for Canét carriage.

CLOTH, ROPE, THREAD, ETC.

120	yards buckram.
206	yards braid.
100	yards carpeting.
$52\frac{2}{3}$	yards canvas.
$51,108\frac{1}{2}$	yards cotton cloth.
261	yards cloth, oiled and enameled.
2	yards cloth, rubber.
5	yards cloth, woolen.
$292\frac{1}{4}$	yards gray felt.
13,093	pounds cotton waste.

1,062¼	pounds cord and twine.
450	yards cord and twine.
225	yards canton flannel.
233	yards flannel.
790	pounds hair.
306½	pounds marline.
10	pounds masons' line.
150	yards matting.
8	door mats.
36	pounds oakum.
27,551	pounds rope.
24	pounds sewing silk.
2,422	pounds thread.
169	spools thread.
27	yards toweling.
156	towels.
61,405	yards cotton webbing.
6	door screens.
88	window shades.
14	window screens.
3,570	pounds jute.
25	pounds asbestos yarn.
60	pounds woolen yarn.
10,000¼	pounds woolen serge, scarlet, 36 inches.

FORAGE.

7,310	pounds barley.
23,969	pounds bran.
1,382¼	bushels corn.
35½	barrels flour.
241¾	bushels grass seed.
11,206	pounds ground-feed.
155$\frac{1905}{2000}$	tons hay.
12,790	pounds cornmeal.
9,002¾	bushels oats.
17	barrels salt.
1,776	pounds salt.
47$\frac{850}{2000}$	tons straw.

IRONMONGERY, ETC.

25	anchors.
3,487	pounds anchors.
1,802½	pounds Babbitt metal.
8	bath tubs and fixtures.
15,222	bolts, carriage, tire, etc.
150	pounds bolts, railroad.
5	boilers.
55	blind fixtures.
339	pounds brads.
8	papers brads.
2,040	pounds beams, channel, etc.
4,116	pounds brass rods.
187,120¼	pounds brass, sheet.
3	square feet perforated sheet brass.

515	pounds burrs.
47,156	buttons.
1,918½	pounds aluminum bronze.
4,262⅜	pounds bronze and brass castings.
170,687⅛	pounds iron castings.
8,119¾	pounds steel castings.
11½	sets castors.
10,316	pounds chain.
2,024¾	feet chain.
32,948½	pounds bar copper.
12,030¾	pounds cartridge copper.
9,193	pounds sheet copper.
336	cocks, assorted.
700	couplings.
1	set couplings.
96	escutcheons.
1,837	door catches and fixtures.
2	sets door catches and fixtures.
231,000	eyelets.
3	wrought-iron girders.
1,318	pennyweights gold.
2,880	grommets.
548	gas burners.
20	pounds gas fittings.
2	papers glaziers' points.
1,494½	pairs hinges.
400	pounds hooks.
1,702	hooks, assorted.
46	hooks and staples.
10,216	horseshoes.
4,320	pounds horseshoe nails.
15	combination hose nozzles.
193 462/2240	tons pig-iron.
2,134	pounds hoop iron.
27,808½	pounds sheet iron.
243,693½	pounds wrought iron.
325	knobs, assorted.
180	keys and blanks.
400,255	pounds pig lead.
3,028	pounds sheet lead.
728	locks, assorted.
50	feet lightning rods (copper).
4	pounds mica.
6	sheets mica.
65,411½	pounds nails.
9,792	saddlers' nails.
17,475¼	pounds nuts.
1,695	nuts, assorted.
406	pulleys.
621	pounds sash pulleys.
896	pounds sash weights.
8,466⅓	pounds lead pipe.
504	pounds brass pipe.
31,267¾	feet iron pipe.
100	feet block-tin pipe.
185½	pounds pipe fittings.

4,091	pipe fittings, various.
14	pumps.
40	radiators.
15	reducers.
288	rivets.
5,751¾	pounds rivets, assorted.
1,459¾	pounds rivets and burrs.
4,535	feet metallic rope.
93	pounds metallic rope.
1,807¾	gross screws.
1,960	screws, assorted.
48½	pounds lag screws.
302 83/144	gross screw pins.
392	screw eyes.
1,800	silver pins.
57	pounds sheet German silver.
72 40/240	pounds silver plate.
6	sinks.
7241/2	pounds solder.
6,450	pounds spikes.
242,897	pounds steel girders.
224	pounds staples.
322,881½	pounds bar and plate steel.
41,035	pounds steel forgings.
17,463½	pounds sheet steel.
3,238,580	tacks, assorted.
471¾	pounds tacks, assorted.
31,126½	pounds block tin.
697	pounds tin foil.
6	boxes sheet tin.
672	sheets tin.
242¾	pounds tubing.
359	feet tubing.
1,492⅔	pounds washers.
120	washers.
14	water-closets and urinals.
6,138¾	pounds brass wire.
1,839	pounds barb wire.
2,295	pounds bronze wire.
10,257⅞	pounds copper wire.
11,772	pounds copper cartridge wire.
60¾	pounds insulated copper wire.
720¾	feet insulated copper wire.
4	pounds piano wire.
7,772¾	pounds iron wire.
40,950	feet iron wire.
228	pounds galvanized-iron wire.
⅓	pound German-silver wire.
1,294½	pounds steel wire.
1	pound platinum wire.
54	feet platinum wire.
1	pound silver wire.
5,055¾	square feet wire cloth.
110	square feet wire fencing.
11,980	pounds plate, frogs, etc., for railroad.
577	plates, etc., for railroad.
4	window fixtures.

30 sets window fixtures.
10,468 pounds zinc.
100 feet zinc.
95 234/2240 tons steel rails.

LEATHER, ETC.

600 feet belt lacing.
2947/8 pounds black wax.
2 cakes black wax.
80½ pounds bristles.
8,892½ feet leather belting.
299 pounds buff leather.
18 pounds bridle leather.
75,944 pounds harness leather.
4¾ pounds lace leather.
18 pounds russet leather.
6½ pounds calfskin leather.
24,310¼ square feet bag leather.
90,947½ square feet collar leather.
5,006¼ square feet bridle leather.
110 square feet enameled leather.
1,415 square feet lace leather.
158½ square feet russet leather.
18½ square feet patent leather.
2 sides morocco leather.
1 side harness leather.
19 sides lace leather.
3 sides russet leather.
340 sides bridle leather.
220 sheepskins.
3 rubber bands for band saws.
822 feet rawhides.

LUMBER.

696,665¾ feet boards.
28,854 feet joists.
534,002¼ feet plank.
73,329½ feet scantling.
2,592 feet strips.
300 pine strips.
310,652½ feet timber.
14,100 laths.
106,628 shingles.
22 pieces timber.
188 posts.
60 piles.
560 feet piles.
20 poles.
250 railroad ties.
148 fire-slabs.

BUILDING MATERIAL.

319 pounds asbestos flour.
346 feet asbestos.

99,300	bricks.
3,867⅔	barrels cement.
18	bushels fire clay.
94¾	barrels fire clay.
12	tons fire clay.
3,963½	feet drain pipe.
127	drain-pipe bends, etc.
3,983½	feet window glass.
2,979	lights window glass.
57¼	bushels plastering hair.
250	pounds plastering hair.
324¼	barrels lime.
96½	bushels lime.
1,870	feet moldings.
13	barrels plaster of Paris.
9	barrels calcined plaster.
3,990	feet tarred paper.
524	pounds tarred paper.
48¼	cubic yards building sand.
273	bushels sand.
1,031	cubic yards stone.
500	slates.
5	squares slate.
82½	tons fire sand.
101¾	bushels fire sand.
530	feet weather strips.
455½	feet iron gutter spout.
300	feet conductor pipe.
6	sets window blinds.
4	pairs window sash.
55	window sash.
46 66/100	squares asbestos roofing.
4	stone steps.
4	doors and frames.
3	flights iron stairs.
4	bags adamantine plaster.
21½	barrels coal tar.
1,296	yards gravel.
7	capstones.
2	door sills.
11	lintles.
5	gallons Crocket's preservative.
138	rolls wall paper.
101	yards wall paper.

MATERIALS FOR HEATING, LIGHTING, CLEANING, ETC.

196	bath bricks.
10	quarts blacking for leather.
980	corn brooms.
125	brushes, dusting, etc.
153 47/100	square feet card clothing.
382	pounds candles.
333	chamois skins.
16,344½	bushels charcoal.

70 barrels charcoal.
4,333 1 1/2 2 2/4 0 tons anthracite coal.
2,613 1 2/2 2 2/4 0 tons bituminous coal.
212 4/2 6 4/2 4 0 tons coke.
128 pounds corundum.
549 corundum and emery wheels.
65 2/2 0 reams crocus and emery cloth.
3,992 pounds crocus and emery.
28 reams emery paper.
43¾ cords firewood.
1 barrel "kem-kom."
14 grates.
6 grate fixtures.
2 brass fenders.
4 spark guards.
18½ tons kaolin.
332 lamps.
344 lamp fixtures.
88 lanterns.
16 lantern fixtures.
194 lamp wicks.
1½ pounds lamp wick.
14½ gross matches.
132 mops and handles.
150 pounds paraffine.
10 pounds paraffine wax.
175 pounds pumice stone.
200 pounds rosin.
198 pounds rotten stone.
25 1/2 7/0 reams sandpaper.
250 yards sandpaper.
168 cakes soap.
469½ pounds soap.
398 gallons soft soap.
17 barrels sea-coal facings, etc.
9,782 pounds sea-coal facings, etc.
262 pounds sponge.
10 stoves, various.
24 stove fixtures.
12 papers stove polish.
382½ feet stovepipe.
153 pounds stovepipe.
3,300 pieces stovepipe.
171 stovepipe elbows.
350 pounds tripoli.
6 wash basins and bowls.
76,968 fire brick.
5 sets fire brick.
222½ tons molding sand.
2 pounds polishing paste.
50 boxes Putz pomade.
8 pounds Putz pomade.
51 gallons Stuart's boiler purge.
1 cedar tank.

MATERIALS FOR OFFICE USE.

5	waste baskets.
60	books, reference.
7	chairs.
1	office table.
1	desk.
500	sheets cardboard.
24	sheets stencil board.
481	yards drawing paper.
$7\frac{10}{24}$	quires drawing paper.
74	bottles India ink.
2	sticks India ink.
58	pieces India rubber.
597	drawing instruments.
7	sets drawing instruments.
$25\frac{16}{20}$	reams paper.
120	sheets oiled and blotting paper.
18	boxes seals.
20,000	seals.
315	yards tracing cloth.
21	rolls tracing cloth.
366	thumb tacks.
$160\frac{1}{2}$	gross pens.
998	pencils, crayons, etc.
21	boxes pencil leads.
3	boxes crayons.
2	hektographs and typewriters.
6	slates.
32	parts hektographs and typewriters.
287	bottles ink.
559	pounds printing ink.
28,800	envelopes.
2	clocks.
4,300	dials for watch clock.
93	bottles mucilage.
4	mucilage stands and brushes.
235	pounds sealing wax.
24	pads.
210	pounds roller composition.
4,200	tags.
44	pounds type.
5,050	labels.
12	boxes labels.
1	letter press.
1,000	eyelets.
7	boxes paper fasteners.
3,500	paper fasteners.
9	papers pins.
6	gross rubber bands.
81	articles, various.

LABORATORY USE.

$37\frac{1}{8}$	gallons acid.
$17,572\frac{1}{2}$	pounds acid.

2701/8 gallons alcohol.
38 pounds alum.
25 pounds aqua ammonia.
205 pounds beeswax.
100,323 pounds ground bone.
70 pounds borax.
20 electric batteries.
550 parts electric batteries.
257 bottles, jars, etc.
40 pounds camphor.
39 carboys.
34 crucibles.
346 pounds chalk.
864 1/2 spheres chalk.
12 bottles chloride of gold.
180 grains chloride of gold.
300 pounds chloride of lime.
4,926 corks.
128 pounds concentrated lye.
106 cans concentrated lye.
900 pounds electropion fluid.
5,929 electrical supplies.
1 pound electrical supplies.
325 pounds sulphate of copper.
25 pounds ammoniated sulphate of copper.
50 pounds flaxseed meal.
181 glass tubes, etc.
54 sets watch glasses.
2,711 pounds glue.
1 gallon glue.
901/4 pounds belt cement.
52 gallons glycerine.
215 pounds glycerine.
21 pounds gum arabic.
75 pounds gum tragacanth.
1 1/2 gallons horse medicine.
14 bottles horse liniment.
50 pounds insect powder.
15 bottles insect powder.
185 1/4 pounds iron and its preparations.
103 pounds mercury.
10 1/2 pounds bichloride of mercury.
50 pounds spirits of niter.
1 gallon spirits of niter.
75 pounds bichromate of potash.
3 pounds carbonate of potash.
20 pounds chloride of potash.
2 pounds cyanide of potash.
187 pounds chlorate of potash.
1 1/2 pounds bromide of potash.
10 pounds hydrate of potash.
30 pounds neutral oxalate of potash.
1,382 pounds potash.
3 2/20 reams paper.
54,210 pounds paper.
554 rolls paper.

1,013¾ yards paper.
36½ pounds sal ammoniac.
14,940 pounds sal soda.
130 pounds sulphur.
34,086½ pounds strawboards.
1,355 pounds tallow.
12¼ barrels coal tar.
48 thermometers.
1 alcohol meter.
1 apothecary's balance.
538 photographic supplies.
3,675¾ pounds soda and its preparations.
561 pounds chemicals, various.
10¼ gallons chemicals, various.
53 gallons molasses.
10 gallons whisky.
244 gallons vinegar.
6 pounds tobacco.

PAINTS, OILS, ETC.

37 gallons asphaltum.
423¾ gallons dryer.
36,049½ gallons gasoline.
310 pounds kalsomine.
25 pounds alabastine.
51 gallons lacquer.
425 pounds lampblack.
25 pounds extract of logwood.
113 gallons benzine.
539 pounds red lead.
220 pounds black lead.
26,113 pounds white lead.
591½ gallons naphtha.
49½ gallons castor oil.
123¾ gallons cod-liver oil.
1 gallon harness oil.
160¼ gallons neatsfoot oil.
14,412¼ gallons illuminating oil.
12,385½ gallons lubricating oil.
24 bottles lubricating oil.
3,674¼ gallons linseed oil.
467 pounds putty.
61 gallons paint.
4,176 pounds paint, in oil.
13,788¼ pounds paint, dry.
686 pounds shellac.
39 gallons shellac.
1,045½ gallons spirits of turpentine.
229 gallons varnish.
6 bottles varnish.
3,693 pounds whiting.
3,121⅔ gallons petroleum.
408 pounds petroline.
761 pounds lubricating compound.
219 quarts cosmic.

2	boxes Royal gilding.
510¼	pounds zinc.
20	pounds hard-oil finish.
40	pounds nut galls.

MISCELLANEOUS ARTICLES.

12	rubber gaskets.
108	rubber rings.
74	rubber washers.
122	rubber valves.
4½	pounds rubber rods.
46¾	pounds rubber gaskets.
1¾	pounds sheet rubber.
543	pounds packing, assorted.
1½	yards rubber packing.
5	horses.
1	mule.
3,737	feet rubber hose.
2,154½	pounds axle grease.
144	cans axle grease.
2	sets post harness.
362	parts post harness.
1	horse blanket.
15¼	pounds gutta-percha.
18	horse covers.
1	dumping cart.
1	express wagon.
1	spring cart.
1	platform car.
4	wheels for handcart.
3	wagon springs.
27	ash cans.
57	oil barrels, etc.
7	whips.
161	whipstocks.
46	quarts harness dressing.
24	cans harness dressing.
593	tin cans.
200	powder canisters, 5 pounds.
50	powder canisters, 2 pounds.
2,110	pasteboard boxes.
139	ammunition chests.
4	rolls electric tape.
2	finger cots.
8	pairs rubber boots.
2	rubber coats.
5	rubber aprons.
6	pairs rubber gloves.
10	pairs magazine slippers.
45	gallons belt dressing.
386	feet rubber tubing.
1,650	railroad and bridge tickets.
124	shade and ornamental trees.
12	baskets.
2	mirrors.

1 tool chest.
5 electric bells.
60 cords manure.
$2\frac{2160}{2240}$ tons fertilizers.
$2\frac{1}{2}$ loads sawdust.
1,055 pounds shavings.
1 flagstaff.

MACHINES, ETC.

1 crow for drilling and tapping street water mains.
1 milling machine.
1 gear-cutting attachment.
1 grinding machine.
1 splitting machine.
1 centering machine, No. 1.
1 profiling machine, complete.
1 wood-boring machine.
1 milling machine, No. 0.
1 tapping machine, No. 1.
5 screw machines, No. 5.
1 rotating machine.
1 molding and sash machine.
1 sewing machine.
1 drill-grinding machine with pointing attachment.
1 universal milling machine, No. 3, complete.
1 milling machine, vertical spindle, No. 2.
2 screw machines, wire-feed, Nos. 1 and 2.
1 saw-sharpening machine.
1 shaping machine, 26-inch stroke, complete.
1 screw machine, Niles, No. 3.
1 horizontal boring and drilling machine.
2 universal milling machines, heavy.
1 vertical milling machine, heavy, complete.
1 screw machine.
1 bolt and nut-facing machine.
2 radial drilling machines, 72-inch, complete.
3 cylinder-boring machines for 12-inch hoops.
2 shaping machines, 26-inch.
1 drilling machine (2 spindles).
1 boring machine.
1 center-bolt cutter, complete.
2 Dallett's portable drills, No. 3, complete.
1 vertical drill, 24-inch.
1 vertical drill, 36-inch.
1 drill, 50-inch.
2 Stowe's flexible shafts, No. 9, with drill press, complete.
2 engine lathes, 8-foot bed, 14-inch swing, complete.
1 engine lathe, 10-foot bed, 20-inch swing, complete.
1 engine lathe, 20-foot bed, 20-inch swing, complete.
1 engine lathe, 20-foot bed, 33-inch swing, complete.
1 engine lathe, 24-foot bed, 36-inch swing, complete.
3 engine lathes, 16-inch swing, standard screw-cutting.
1 engine lathe, 13-inch swing, screw-cutting.
1 engine lathe, 72-inch.

1 engine lathe, screw-cutting, 6 feet 6 inches bed, 16-inch swing.
1 engine lathe, screw-cutting, 7-foot bed, 16-inch swing.
1 engine lathe, 30-inch swing, complete.
1 lathe, hand, universal.
1 lathe, boring, complete.
6 lathes, turning and boring, first class.
4 lathes, turning and finishing, second class.
1 lathe, turning and boring hoops, 60-inch, 15 feet between centers.
2 lathes, turning and boring hoops, 60-inch, 12 feet between centers.
3 lathes, turning and boring hoops, 48-inch.
2 lathes, turning and boring jackets.
4 lathes, 36-inch, complete.
4 lathes, 22-inch, complete.
2 lathes, 16-inch, complete.
1 lathe, screw-cutting, No. 2.
1 grinder, horizontal double, No. 8.
1 grinder, upright, No. 12.
1 grinder, gouge, and cutter, No. 4.
1 grinder, twist drill, No. 2.
1 grinder, cutter, and reamer, No. 3.
1 grinder, emery wheel, No. 5, complete.
1 grinder, tool, Springfield, No. 2.
1 vertical boring and turning mill, 16 feet, complete.
1 vertical boring and turning mill, 72-inch.
1 Sturtevant pressure blower, No. 7.
1 planer, 72-inch.
1 planer, 32 by 32 inches by 8 feet.
1 planer, 44 by 44 inches by 10 feet.
1 press, leather-cutting, 36-inch.
1 slotter, 12-inch.
1 motor, Porter, No. 3.
1 dynamo electric motor.
1 dynamo electric generator.
1 air compressor.
2 fuel-oil burners.
1 locomotive engine.
1 gas engine.
1 blower, complete.
1 drop hammer.
1 freight elevator.
1 excavator.
1 platform sprinkler.
1 4-ton wagon scale.
1 gas retort.
1 gas meter.
1 steam hoisting engine.
1 steam boiler.
1 steam pump.
1 smokestack.
1 cupola furnace.
22 agricultural machines, various.
416 parts agricultural machines.

135 parts of machines.
2 hot-air improved compression engines, complete.

INSPECTING INSTRUMENTS.

10 engineers' transits, complete.
22 azimuth instruments, complete.
10 leveling rods.
10 marking pins.
1 caliper, Vernier, 80-inch, with case.
2 step gauges, with three blades, complete.
1 caliper, micrometer, No. 16.
2 chronographs, Boulangé.

TOOLS, ETC.

142 awls.
92 axes.
13 augers.
276 braces and bits.
8 sets bits.
109 water buckets.
2,499 brushes, paint, and sash tools, etc.
86 chisels.
2 sets chisels.
798 chalk lines.
28 coal hods.
269 carpenters' tools, various.
1 set carpenters' tools.
432 drills.
3 sets drills.
18 dies.
5,787 files.
41 hay and manure forks.
17 gauges.
40 gouges.
96,273 pounds grindstones.
7 grindstones and frames.
117 hatchets and hammers.
2,633 handles, assorted.
34 hoes.
1 inspirator.
34 knives, assorted.
2,950 lubricators.
81 levels, spirits, etc.
149 machinists' tools, various.
5 sets machinists' tools.
11 mallets.
107 nippers.
1 nail puller.
36 saddlers' needles.
624 oil cups and oilers.
839 oil stones and slips.
112 picks.
424 punches, assorted.
2 pumps.
148 rakes, hay and garden.

142 rasps.
81 rules.
34 riddles.
519 spades and shovels.
95 saws.
516 saw blades.
81 scythes, etc.
103 scythestones.
16 scythe snaths.
37 stamps, letters and figures.
2 sets stamps.
2 scales and weights.
166 smiths' tools, various.
9 squares.
32 tape lines.
130 wrenches.
88 wheelbarrows.
8 pairs shears.
204 tools, various.
7 tinners' tools, various.
52 vises.
28 utensils, various.

APPENDIX 3.

Statement of ordnance, ordnance stores, etc., issued to the Military Establishment, including the national homes for soldiers of the volunteer and regular Army and exclusive of the militia, during the fiscal year ended June 30, 1892.

CLASS I.

4 Gatling guns, 10 long barrels, caliber .45.
4 10-pounder Parrott guns.
5 3-inch rifled guns.
12 3.2-inch breech-loading rifles.
23 8-inch converted rifles.
2 6-pounder guns.
2 12-pounder field howitzers.
2 8-inch siege mortars.
6 10-inch siege mortars.
1 12-inch cast-iron steel-hooped mortar.

CLASS II.

4 metallic carriages for machine guns, with mounts for Gatling gun.
2 3-inch gun carriages and limbers.
4 3-inch gun carriages without limbers.
41 3.2-inch breech-loading field-gun metallic carriages.
1 12-pounder gun carriage without limber.
1 3-inch gun caisson and limber.
2 3-inch gun caissons without limbers.
8 3.2-inch gun caissons and limbers.
4 limbers for machine-gun carriages.
14 limbers for 3.2-inch gun carriages.
1 7-inch breech-loading howitzer steel carriage.
2 8-inch howitzer carriages and limbers.
18 8-inch carriages and chassis, hydraulic cylinders.
1 12.25-inch muzzle-loading rifle carriage and chassis.
17 15-inch carriages and chassis, hydraulic cylinders.
2 12-pounder mountain-howitzer carriages.
2 8-inch siege-mortar beds.
5 10-inch siege-mortar beds.
5 portable forges.
2 portable forge chests.
3 forges and battery wagons, combined.
4 mortar wagons.

CLASS III.

11 baskets for mortar implements.
1 breech cover, 8-inch gun.
1 breech cover, 10-inch gun.
1 breech cover, 12-inch breech-loading gun.
1 breech cover, 12-inch breech-loading mortar.
4 breech sights, 4.5-inch gun.
60 breech sights, 8-inch gun.
36 breech-sight seats, 8-inch gun.
163 buckets, canvas.
17 buckets, gutta-percha.
2 buckets, iron, sponge.
1 bucket, rubber.
1 bucket, wood, forge.
14 carrying bars.
25 chocks, gun.
36 chocks, wheel.
1 driver's boot, artillery wagon.
17 elevating bars.
2 front sights, 3-inch rifle.
36 front sights, 8-inch rifle.
4 fuse blocks.
2 fuse-cutting tools.
4 fuse mallets.
4 fuse saws.
11 gunners' gimlets, field.
5 gunners' gimlets, siege.
67 gunners' haversacks.
1 gunners' pincers.
20 gunners' pouches.
7 gunners' quadrants.
45 gunners' sleeves.
9 handspikes, maneuvering, new model caisson.
48 handspikes, maneuvering, 7 feet long.
36 handspikes, maneuvering, 8-inch carriage.
34 handspikes, maneuvering, 15-inch carriage.
114 handspikes, maneuvering, wood.
36 handspikes, rear.
13 handspikes, shod.
14 handspikes, trail, field gun.
1 handspike, trail, mountain howitzer.
2 handspikes, wood, mortar wagon.
157 harness bags.
19 sets harness for two lead horses.
24 sets harness for two wheel horses.
1 lantern, dark.
1 lantern, footboard.
4 lanterns, globe.
1 lantern, hand.
6 lanterns, magazine.
12 lanterns, tubular.
47 lanyards for friction primers.
9 muzzle covers and straps.
2 oilers, brass.
25 pass boxes.

3 paulins, 6 by 10 feet.
6 paulins, 8 by 10 feet.
4 paulins, 12 by 12 feet.
12 paulins, 12 by 15 feet.
2 paulins, 20 by 30 feet.
2 pendulum hausses, 3-inch gun.
2 pendulum hausses, 12-pounder gun.
8 pendulum hausse pouches.
18 pinch bars, 8-inch carriage.
17 pinch bars, 15-inch carriage.
30 plummets.
1 pointing scale, mortar.
20 powder funnels.
22 powder measures.
6 powder scoops.
19 priming wires.
4 prolonges.
25 props for sponge and rammer.
1 quoin.
8 rammers and staves, 4.5-inch gun.
35 rammers and staves, 8-inch gun.
13 scrapers for gun.
300 securing stakes.
8 shell hooks.
38 shot hooks.
11 sight pouches.
37 slippers, magazine, pairs.
2 sponge covers, 12-pounder.
11 sponge covers, 3-inch.
2 sponge covers, 4.5-inch.
8 sponge covers, 8-inch.
10 sponge covers, 10-inch.
4 sponge covers, 15-inch.
40 sponges and rammers, 3-inch.
14 sponges and rammers, 6-pounder.
10 sponges and rammers, 12-pounder.
5 sponges and rammers, mountain howitzer.
65 sponges and staves, 8-inch gun.
8 sponges and staves, 13-inch mortar.
5 sponges and staves, 15-inch gun.
23 thumbstalls.
3 tompions, 6-pounder.
11 tompions, 12-pounder.
9 tompions, 3-inch.
1 tompion, 4.5-inch.
15 tompions, 8-inch.
19 tompions, 10-inch.
2 tompions, 12-inch.
28 tompions, 15-inch.
111 tube pouches.
28 vent covers, field gun.
13 vent covers with springs.
30 vent covers, 8-inch rifle.
5 vent covers, 10-inch gun.
27 vent covers, 15-inch gun.
24 vent pieces.

1 vent plug tap.
1 vent plug tap wrench.
2 vent punches, field.
8 vent punches, siege.
8 water tubs.
72 wipers for mortar.
6 worms and staves, field gun.

APPENDAGES FOR GATLING GUN, CALIBER .45.

4 drifts.
8 feed guides.
2 gun covers.
4 lock screw-drivers.
4 small screw-drivers.
4 T screw-drivers.
4 shell drivers.
4 wiping rods.
4 cascabel wrenches.
4 lever axis pin wrenches.
4 pin wrenches.
4 rear guide nut wrenches.
4 wiping rods for Hotchkiss revolving cannon, 1.5-inch.

IMPLEMENTS FOR HOTCHKISS MOUNTAIN GUN, CALIBER 1.65-INCH.

4 ammunition boxes.
4 boring bits.
6 breech covers.
2 breech sights.
6 bricoles.
5 cleaning brushes.
3 grease boxes.
6 gun covers.
1 lanyard.
6 muzzle covers.
6 oil cans.
4 primer boxes and belts.
1 punch.
1 screw-driver.
2 spare ropes.
6 sponges, bristle.
1 vent-reamer.
5 wrenches, fuse.

IMPLEMENTS FOR 3.2-INCH BREECH-LOADING RIFLE.

8 breech covers.
20 breech sights, bronze.
16 breech-sight pouches.
37 breech straps.
25 buckets, galvanized iron.
18 front sights, bronze.
14 front-sight covers.
11 gunners' gimlets.
31 gunners' haversacks.

8 gunners' reamers.
24 lanyards, new pattern.
14 muzzle covers and tompions combined.
61 paulins, 11 by 11 feet.
14 primer pouches.
8 priming wires.
23 prolonges (sections picket-rope).
12 screw-drivers, combination.
26 sponge covers for bore sponge.
35 sponge covers for chamber sponge.
35 sponges and rammers with staves (bore).
40 sponges and rammer (chamber).
10 vent punches.

CLASSES IV AND V.

SHOT.

50 3-inch rifle.
267 8-inch, cored.
66 8-inch, cored, chilled.
53 8-inch converted rifle.
188 10-inch breech-loading rifle, banded.

SHELL.

100 1.5-inch Hotchkiss.
200 1.65-inch Hotchkiss.
50 3-inch rifle.
1,432 3.2-inch breech-loading rifle.
30 4.5-inch rifle.
212 12-pounder field gun.
100 24-pounder gun.
62 8-inch rifle.
25 8-inch experimental.
88 8-inch smooth-bore gun.
413 8-inch mortar.
4 10-inch gun.
493 10-inch mortar.
200 12-inch breech-loading rifled mortar, banded.
104 13-inch mortar.

CANISTER.

50 3-inch rifle.

SHRAPNEL.

12 3.2-inch breech-loading rifle.

CLASS VI.

1,669 Springfield carbines.
200 Springfield cadet rifles.
3,725 Springfield rifles.
183 Springfield rifles, rod bayonet.
5 Springfield rifled muskets, caliber .58.

60 Springfield shotguns.
1,023 Colt's revolvers.
17 Schofield-Smith and Wesson revolvers.
33 artillery sabers.
1 artillery officer's saber.
454 light cavalry sabers.
37 musicians' swords.
53 non-commissioned officers' swords.
15 officers' swords.
79 hospital corps knives.
2,685 intrenching knives.

CLASS VII.

APPENDAGES.

9 cleaning rods, shotgun.
2,098 headless shell extractors.
1,346 jointed ramrods.
1,745 screw-drivers, combination.
255 screw-drivers, revolver.
41 spring vises.
149 tumbler punches.
1,324 wiping rods, carbine.
22 wiping rods, revolver.
3,526 wiping rods, rifle.
10 wiping rods, shotgun.

ARTILLERY EQUIPMENTS.

5 knapsacks.
145 saber belts.
84 saber-belt plates.

CAVALRY EQUIPMENTS.

1,524 canteen straps.
945 carbine slings.
985 carbine sling swivels.
827 cartridge belts.
397 pistol cartridge boxes (cap pouches).
985 pistol holsters.
747 saber attachments.
1,653 saber belts.
964 saber-belt plates.
1,853 saber knots.

INFANTRY EQUIPMENTS.

1 bayonet scabbard, leather.
2,102 bayonet scabbards, steel, Hoffman attachment.
2,395 bayonet scabbards, steel, hook attachment.
2,241 blanket bags.
3,597 blanket-bag coat straps.
2,576 blanket-bag shoulder straps.
7,885 canteens.

5,142 canteen straps.
3,199 cartridge belts.
1,956 cartridge-belt plates.
229 cartridge boxes, cadet.
1 cartridge box, caliber .58.
3,409 cartridge boxes, McKeever.
3,837 clothing bags.
4,052 clothing-bag straps.
19 coat straps.
98 frogs, sliding.
6,385 gun slings.
7,384 haversacks.
6,422 haversack straps.
1 haversack and strap, Quartermaster's Department.
4,976 knives.
4,589 forks.
4,739 spoons.
5,285 meat cans.
79 scabbards, hospital corps knife.
2,632 scabbards, intrenching knife.
58 scabbards, intrenching tool.
6,119 tin cups.
4,436 waist belts.
2,192 waist-belt plates.
190 non-commissioned officers' waist belts.
189 non-commissioned officers' waist-belt plates.

HORSE EQUIPMENTS.

1,203 bridles, curb.
1,641 bridles, watering.
906 carbine boots and straps.
194 cinches.
1,428 coat straps, saddle.
1,956 currycombs.
3,819 halters.
6,597 halter straps.
100 hoof hooks.
2,787 horse brushes.
149 horse covers.
1,946 lariats.
1,200 links.
2,032 nosebags.
810 picket pins.
693 saddles.
17 saddle bags, canvas.
917 saddle bags, leather.
249 saddle blankets, artillery.
4,239 saddle blankets, cavalry.
50 saddle cloths.
446 side lines.
2,207 spurs.
2,608 spur straps.
14 stirrups with guidon sockets.
1,604 stirrups, wood.
1,342 stirrup straps.
1,601 surcingles.

CLASS VIII.

SMALL-ARMS AMMUNITION.

383,460	carbine ball cartridges.
571,199	revolver ball cartridges.
556,100	revolver blank cartridges.
846,585	rifle ball cartridges.
491,000	rifle and carbine blank cartridges.
216	shotgun cartridges.
1,441,168	carbine bullets.
451,800	revolver bullets.
2,659,404	rifle bullets.
500	rifle bullets, caliber .30.
136,500	round balls.
45	pounds buckshot.
6,467,815	cartridge primers.
500	cartridge shells, rifle.
9,189	cartridge shells, shotgun.
49,766½	pounds small-arms powder.
8,645	pounds shot.
218,925	wads, shotgun.

AMMUNITION FOR CANNON.

Blank cartridges.

1,315	½-pound charge.
5,481	1-pound charge.
4,987	1¾-pound charge.
5,050	2½-pound charge, 3.2-inch rifle.
1,395	3¾-pound charge, 3.2-inch rifle.
20,342	3-inch rifle.
2,126	6-pounder gun.
15,681	12-pounder gun.
6,750	pounds balls for 3.2-inch shrapnel.

Fuses.

100	base, 3.2-inch shell.
54	combination.
320	paper.
100	percussion.
811	wood.

Powder.

23,985½	pounds cannon.
22,121	pounds hexagonal.
22,660	pounds mammoth.
12,050	pounds mortar.
47,031½	pounds sphero-hexagonal.

Primers.

1,945	electric.
114,494	friction.

CLASS IX.

32 arm racks, carbine and revolver.
68 arm racks, rifle and revolver.
20 azimuth instruments, complete.
1 bail, 10-inch Rodman.
1 set blocks for mounting 10-inch gun.
406 blocks, assorted sizes, wood.
109 blocks, double, wood.
2 sets blocks, gin fall.
14 blocks, half.
1 block, pulley.
4 blocks, quadruple, iron.
14 blocks, quarter, wood.
110 blocks, single, wood.
101 blocks, treble, wood.
18 blocks, whole, wood.
7 capstans.
8 capstan bars.
92 chocks, roller.
52 chocks, wheel.
9 chronographs.
2 cradles, 8-inch rifle.
1 cradle, 10-inch rifle.
2 cradles, siege gin.
1 cradle, 15-inch gun.
18 cranes, 8-inch carriage.
17 cranes, 15-inch carriage.
23 eccentric trunnion rings and keys.
2 field cases, shotgun supplies.
9 firing machines, magnetic.
6 gins, field and siege.
3 gins, garrison.
1 gin block.
3 gin falls, casemate.
2 gin falls, field and siege.
4 gin falls, garrison.
29 gin handspikes.
2 gin journal boxes.
6 gin shoes.
4 gin slings.
752 gunners' badges.
2 hand-barrows.
2 handcarts.
12 holdfasts.
58 intrenching tools.
1 jack, hydraulic, lifting, 20 tons.
5 jacks, hydraulic, lifting, 30 tons.
1 jack, hydraulic, pulling, 20 tons.
3 levers with adjustable fulcrums and blocks.
24 marking outfits.
2 marking outfit ink pads.
2 marking outfit inking sticks.
1,900 marksman's buttons.
452 marksman's pins.
7 platforms, gun.

11 platforms, mortar.
22 pulleys, differential.
18 sets pulleys, hoisting.
1 range and position finder.
96 rollers, oak, assorted sizes.
25 rollers, cradle.
54 rollers, long.
56 rollers, short.
4 sand glasses.
597 sharpshooters' badges.
160 silver bars for sharpshooters' badges.
1 shear falls with block for gun lift.
2 sheaves, gin block.
57 shifting planks.
68 skids.
2 sling carts, large.
1 sling-cart chain, large,
1 sling-cart chain, small.
10 sling chains.
2 slings for cannon, rope.
31 stencil outfits.
10 stencil plates.
1 telescope and tripod.
20 time interval recorders.
40 trace ropes.
10 transits, engineers'.
12 traveling planks.
1 travois.
8 sets trestles for mortar.
1 truck, casemate.
1 truck, store.
68 way planks.

TARGETS AND TARGET MATERIAL.

97 halliards with screw eyes.
13 marking rods, disks, and brushes.
98 marking staves and disks.
215 signal flags.
144 streamers.
26 targets, Brinton.
10 targets, Cushing.
60 targets, floating or towing.
53 targets, iron, gallery practice.
182 targets, Laidley.
28 targets, land.
27,029 targets, paper.
4 target anchors.
88 target axles.
2 target axles with wheel at each end.
16 target cars.
2,370 target centers.
20 target corner braces.
162 target covers.
2 target crates.
169 target crosspieces.

268 target frames, Brinton.
32 target frames, Cushing.
14 target frames, exterior.
376 target frames, interior.
205 target frames, Laidley.
255 target frames, steel.
84 target frames, temporary.
160 targets, Texas.
16 target sustaining rods.
1 target frog switch.
2 target rails.
141 target journal boxes.
350 target journal-box pins.
2 target journal posts.
50 target levers.
128 target lever blocks.
2 target lever boxes.
186 target nave boxes.
9,092,000 target pasters.
1,378 target pins.
79 target rails.
20,512 target silhouettes, cloth.
82,439 target silhouettes, paper.
7 target sill stakes.
16,500 target strings.
100 target track, feet.
117 target uprights.
1 target wheels and cranks, large.
2 target wheels, small.
300 target wooden ties.
848 target wooden wedges.

HAND RELOADING TOOLS.

21 brush-wipers, No. 20 shell.
22 chargers, powder and shot.
2 crimpers, No. 20 shell.
3 dies, resizing.
20 drifts.
22 funnels.
1 gauge, resizing.
31 priming tools.
20 priming tool pins.
2 punches, resizing.

BENCH RELOADING TOOLS.

5 sets bench reloading tools.
2 gauges, total length.

RESIZING TOOLS AND PARTS, BENCH RELOADING TOOLS.

3 resizing tools.
2 cartridge head-adjusting screws.
130 dies, lower.
72 dies, upper, revolver.

551 dies, upper, rifle.
12 lever-pin screws.
2 links.
2 link pins.
16 link-pin screws.
5 rings.
30 spindles.
7 spindle screws.
7 spindle screw nuts.
1 stand.

ASSEMBLING AND CRIMPING TOOLS AND PARTS.

3 assembling and crimping tools.
2 check levers,
6 check lever springs.
8 check lever-spring screws.
41 dies.
4 die holders.
10 die-holder set screws.
6 die-holder stop screws.
1 shell rest.
1 shell rest holder plate.
2 shell rest holder-plate screws.
11 stems, carbine and rifle.
5 stems, revolver.
2 stem carriers.
3 stem levers.
8 stem-lever pins.
2 stem-lever pin screws.
26 stem screws.

POWDER-CHARGING TOOLS, ETC.

3 powder charging tools.
5 chargers and disks.
7 ejector pins.
8 wrenches.

PRIMER-EXTRACTING TOOLS, ETC.

4 primer extracting tools.
448 primer extractor pins.
3 levers.
10 lever pins.
24 spindles.
57 spindle screws.

PRIMER-INSERTING TOOLS, ETC.

1 primer inserting tool.
15 bushings, carbine and rifle.
6 bushings, revolver.
19 bushing screws.
5 pinion levers.
7 pinion lever pins.
9 primer setters.

TOOLS FOR GALLERY PRACTICE.

38 ball molds.
14 ladles, melting.
13 ladles, pouring.
8 strainers.

CLASS X.

PARTS OF CLASS I.

Parts of Gatling gun.

4 axis pins, washers, and nuts.
4 binding boxes, plates, etc.
4 crank handles and pins.
1 lock.
4 pointing levers.

Parts of 3.2-inch breech-loading rifle.

2 bronze handles.
4 bronze handle screws.
1 De Bange obturator.
1 De Bange obturator pad.
6 Freyre obturators.
2 Freyre obturator gas-check rings.
1 rear sight socket.
1 rear sight socket screw.
2 vent bushings.

Parts of 10-inch rifle.

3 bushing rings, brass, for trunnion hoops.

Parts of 12-inch breech-loading mortar.

1 gas-check pad.

PARTS OF CLASS II.

Parts of field gun carriages.

1 cap square.
1 chain toggle.
2 footboards, front.
2 footboards, rear.
12 footboard brackets.
1 elevating screw.
3 lunette props, battery wagon.
12 wheels, artillery, No. 1.
2 wheels, Gatling gun cart.
2 wheels, Hotchkiss mountain gun carriage.
4 poles, siege gun carriage.
2 splinter bars.
6 stay pins, ammunition chest.
1 stay pin, key and chain, limber chest.

Parts of 3.2-inch breech-loading rifle carriage.

101 bow-spring brakes.
2 bronze screw lids for cylindrical iron box.
4 caisson bodies.
4 cap squares.
4 catches for short sponge and rammer.
14 chin bolts.
40 doubletrees, steel.
5 eyebolts.
2 eyebolt keys.
4 handspike clasps.
10 hooks and safety springs for securing spare pole.
42 linchpins.
30 linch washers.
2 neck yokes.
1 nut and pinion for crank shaft and elevator screw.
17 poles, limber.
42 pole props.
3 side rails, left.
4 side rails, right.
80 singletrees, steel.
7 singletrees, wood.
10 spring jaws for securing handspikes.
1 trail-box lid.
26 wheels.

Parts of ammunition chest, 3.2-inch breech-loading rifle.

2 ammunition chests.
12 assembling rivets.
12 burrs.
8 canvas covers.
4 guard plates.
25 hasps.
1 hasp and plate.
12 hinged props.
32 paulin straps.
12 rivet studs.
12 rivets for hasp plates.
6 stay pins.
18 turn-buckles.

Parts of Hotchkiss 3-pounder gun platform.

14 bolts, nuts, and washers.
4 pins, cross-arm ties.

Parts of Gordon disappearing carriage.

54 bolts, platform.
54 washers, platform.

Parts of 8-inch barbette carriage.

4 bolts and nuts with pins and keys.
2 bolts and nuts, buffer.

3 pintle keys.
49 retraction ropes.
1 step.
4 studs, hand-wheel.

Parts of 10-inch barbette carriage.

20 bolts and nuts.

Parts of 15-inch barbette carriage.

18 bolts and nuts.
2 buffers, rubber.
5 floor boards, sets.
5 rear guide hooks and nuts.
1 rear transom.
4 retraction ropes, manila.
17 retraction ropes, steel wire.
12 screws, crosshead cap.
12 screw bolts, rear transom.

Parts of 15-inch carriage adapted for 12-inch mortar.

10 bolts and nuts.
2 braces, left and right.
2 bushings for elevating shaft.
2 bushings for pinion shaft.
2 bushings for trunnion beds.
2 filling pieces.
1 transom, front.
2 transoms, front and rear.

Parts of 12-inch proof-carriage.

1 pintle tongue.

Parts of 10-inch mortar bed.

3 bolsters.

PARTS OF CLASS III.

6 attachments for collar strap.
14 breast straps.
1 breech-sight adjusting screw.
32 bridles, artillery.
24 bridle ornaments.
8 brow bands.
182 buckles, bar, brass-plated.
36 buckles, bar, iron.
206 buckles, rollers, iron.
69 collars.
18 collar bolts and nuts.
12 collar-strap plates for collar.
12 collar-strap plates for saddle.
12 hames, pairs.

144 hame screws.
6 hinges for collar and hames.
12 hooks for breast strap.
14 hooks for breeching.
20 hooks, double S.
36 hooks, stirrup leather.
27 glass tubes for breech sight.
49 lead rein rollers.
20 martingales.
14 martingales with cincha straps.
4 mogul springs.
4 neck-yoke pads, rubber.
2 pole pads, leather.
10 pole pads, rubber.
2 pole props.
2 pole straps.
26 rammer heads.
4 rings, D, martingale.
6 screws for bottom of collar.
4 side-strap hooks.
46 snap hooks for reins.
4 snaps for bottom of collar.
18 sponge heads.
28 sponges, woolen, 6-pounder.
120 sponges, woolen, 12-pounder.
6 sponges, woolen, mountain howitzer.
117 sponges, woolen, 3-inch.
52 sponges, woolen, 3.2-inch (bore).
32 sponges, woolen, 3.2-inch (chamber).
18 sponges, woolen, 4.5-inch.
18 sponges, woolen, 8-inch.
20 sponges, woolen, 10-inch.
6 springs for bottom of collar.
12 springs and snaps for collar.
6 springs and clasps for hames.
4 stirrups, brass.
18 surcingles.
4 traces, lead.
4 traces, wheel.
50 trace chains.
107 whips.

PARTS OF CLASS V.

422 fuse plugs, 8-inch shell.
200 fuse plugs, 10-inch and 15-inch shell.
25 point plugs, Hotchkiss shrapnel.
35 point plugs, 3.2-inch shrapnel.
400 sabots, 15-inch shell.
400 tin straps, 15-inch shell.
200 water caps.

PARTS OF CLASS VI.

Parts of Springfield carbine.

7 bands.
811 front sights.

513 front-sight covers.
198 front-sight cover pins.
566 front-sight pins.
2 guards.
7 guard bows.
58 guard screws.
500 rear sights.
1,428 rear-sight protector bands.
763 stocks, wood part.
22 swivels.
10 swivel bars.
20 swivel-bar rings.

Parts of Springfield rifle.

126 bands, lower.
174 bands, upper.
153 band springs.
61 bayonets.
108 bayonet clasps.
146 bayonet-clasp screws.
30 bayonet-clasp stop screws.
282 breechblock cap screws.
373 bridles.
455 bridle screws.
72 butt plates.
4 butt-plate covers.
2 butt-plate cover screws.
255 butt-plate screws.
426 cam-latch springs.
3 cover springs.
5 cover friction springs.
5 cover spring screws.
12 cover stud pins.
1,111 ejector springs.
1,135 ejector-spring spindles.
154 ejector studs.
1,881 extractors.
2,928 firing pins.
952 firing-pin screws.
422 front sights.
116 front-sight covers.
471 front-sight cover screws.
25 front-sight friction screws.
475 front-sight pins.
59 guard bows.
32 guard bows, swiveled.
89 guard-bow nuts.
138 guard-bow swivels.
193 guard-bow swivel screws.
53 guard plates.
169 guard screws.
242 hammers.
621 hinge pins.
28 hinge-pin studs.
22 locks.

84 lock plates.
421 mainsprings.
12 mainspring screws.
304 mainspring swivels.
254 mainspring swivel rivets.
213 pistol grips.
372 pistol-grip screws.
168 ramrods.
268 ramrod stops.
498 rear sights.
65 rear-sight base screws.
549 rear-sight screws.
60 rod-bayonet heads.
399 sears.
509 sear screws.
583 sear springs.
547 sear-spring screws.
620 side screws.
154 side-screw washers.
124 stocks, complete.
739 stocks, wood part.
10 stocks, rod bayonet, wood part.
402 tang screws.
90 tips.
111 tip screws.
152 triggers.
206 trigger screws.
523 tumblers.
125 tumblers, swiveled.
621 tumbler screws.

Parts of Springfield shotgun.

6 ejector springs.
6 ejector-spring spindles.
38 extractors.
8 stocks, wood part.

Parts of English double-barrel shotgun.

50 plunger springs.

Parts of Parker shotgun.

2 ejectors.
10 firing pins.
10 firing-pin springs.
50 plunger springs.

Parts of Hotchkiss magazine rifle.

2 bolt mainsprings.

Parts of Colt's revolver.

38 back straps.
296 back-strap screws.

328 bolts.
283 bolt screws.
198 center pins.
128 center-pin bushings.
337 center-pin screws.
33 cylinders.
145 ejector heads.
131 ejector rods.
181 ejector springs.
88 ejector tubes.
210 ejector-tube screws.
73 firing pins.
126 firing-pin rivets.
4 frames.
30 front sights.
40 gates.
65 gate catches.
78 gate-catch screws.
118 gate springs.
12 guards.
268 guard screws, long.
262 guard screws, short.
434 hammers.
119 hammer cams.
133 hammer rolls.
139 hammer-roll rivets.
324 hammer screws.
442 hands.
436 handsprings.
188 mainsprings.
209 mainspring screws.
10 sear screws.
78 sear springs.
36 sear-spring screws.
518 sear and stop-bolt springs.
269 sear and stop-bolt spring screws.
178 stocks.
338 triggers.
288 trigger screws.

Parts of Schofield-Smith and Wesson revolver.

6 barrel-catch screws.
6 barrel-catch springs.
1 trigger.
1 blade for cavalry officer's saber.
4 scabbards for artillery officer's saber.
7 scabbards for light-cavalry saber.
5 scabbards for musician's sword.

PARTS OF CLASS VII.

60 brass-hook attachment for bayonet scabbards.
389 bits, curb.
228 bridle ornaments.
40 bridle reins.

9,814	buckles, bar, brass.
1,752	buckles, bar, iron.
2,119	buckles, roller, iron.
4,349	buckles, wire, brass.
867	canteen corks and chains.
3,098	canteen covers.
151	canteen snap hooks.
24	cincha straps.
25	cruppers.
428	curb straps.
131	double-spring snap hooks.
13,268	escutcheon screw pins, brass.
105	girth straps.
776	halter bolts.
25	halter chains.
1,040	halter rings, $1\frac{7}{10}$ inches.
327	halter swivel rings.
683	halter squares.
50	lariat and picket-pin straps.
49	link snaps.
1,738	ovals.
1,643	rings, brass, $1\frac{1}{4}$ inches.
396	rings, iron, D.
2,125	rings, iron, $2\frac{1}{2}$ inches.
36	rivets and burrs, bridle ornament.
39	rosettes.
110	saddle nails, japanned.
419	saber-belt snaps.
874	saber straps.
86	shields.
168	side-line fasteners.
1,265	staples, foot, brass.
2,506	staples for rings, brass.

PARTS OF CLASS VIII.

Cartridge bags.

2,227	6-pounder gun.
6,328	12-pounder gun.
190	12-pounder mountain howitzer.
300	24-pounder gun.
500	32-pounder gun.
2,150	3-inch rifle.
1,525	3.2-inch rifle.
200	4.5-inch gun.
810	8-inch rifle.
2,040	10-inch gun.
650	15-inch gun.

PART SECOND.

CLOTH, ROPE, THREAD, ETC.

14,768	yards cotton cloth.
356¾	pounds cotton waste.

3	yards flannel.
201	feet lashing line.
220	feet marline.
60	pounds marline.
1,850	feet rope.
5,055½	pounds rope.
7	pieces sash cord.
280¾	pounds sash cord.
102¼	pounds patent thread.
458	pounds shoe thread.
72	pounds twine.
290	yards webbing.
65	pounds yarn.

IRONMONGERY.

27½	pounds Babbitt metal.
1	box bolts and nuts.
300	pounds iron bolts.
58¼	pounds sheet brass.
6	door springs.
6	pairs brass hinges.
24	pairs iron hinges.
72	ceiling hooks.
168	coat hooks.
16,850	horseshoes.
1,730	pounds horseshoe nails.
1,773	pounds bar iron.
6	sheets mica.
2	pounds copper nails.
1,165	pounds iron nails.
1	hose nozzle.
30	pounds iron nuts.
165	padlocks.
139	copper recorders.
353¼	pounds brass rivets and burrs.
567	pounds copper rivets and burrs.
267	pounds iron rivets and burrs.
1,100	iron rivets.
6,684	brass screws.
1,188	iron screws.
23	gross iron screws.
1	pound brass solder.
1	ounce silver solder.
5	pounds tinners' solder.
1,400	spikes.
8	pounds bar steel.
13	pounds plate steel.
388	pounds toe steel.
12	cast-iron tablets.
36,100	copper tacks.
16⅛	pounds copper tacks.
1,895,450	iron tacks.
57	pounds iron tacks.
75	pounds brass wire.
254	pounds copper wire.

500 feet copper wire, insulated.
2,072 pounds galvanized iron wire.
200 feet wire rope.

LEATHER, ETC.

2 sides bag leather.
712 sides bridle leather.
20,561 pounds harness leather.
2 sides lace leather.
101 quarts blacking for leather.
1 half box blacking for stencil outfit.
253¼ pounds black wax.
18¼ ounces bristles.
104 boxes ingredients for leather blacking.

LUMBER.

3,723 feet boards.
3,192 feet plank.
192 feet scantling.
5,437 feet timber.

CLEANING, HEATING, AND LIGHTING.

62 bath bricks.
177 corn brooms.
172 button brushes.
155 button sticks.
50 pounds candles.
337 chamois skins.
19 boxes cleaning material.
26 cleaning plates.
20,900 pounds coal.
39 quires crocus cloth.
776 2/20 quires emery cloth.
337½ quires emery paper.
8 lantern globes.
4 lanterns.
470 ounces leather polish.
24 boxes Putz pomade.
356 pounds rottenstone.
121 quires sandpaper.
790 ounces scouring material.
2,250¾ pounds castile soap.
80 pounds common soap.
210 pounds sponge.
1,341 papers tripoli.
1,332 ounces whiting.
14 wire scratch brushes.

OFFICE MATERIAL.

140 battery cells.
10 beam compasses, complete.
42 binding posts.

7 books, Le Boulengé chronograph.
2 bottles Chinese white.
42 connectors.
42 connecting cords.
50 coppers for gravity battery.
1 desk.
6 dividers.
6 drawing boards.
6 sets drawing instruments.
2 door mats.
2 pairs gauntlets.
2 pairs rubber gloves.
1 heliograph.
7 sets colored ink.
88 ounce bottles indelible ink.
59 bottles India ink.
2 ink erasers.
2 ink and pencil erasers, rubber.
336 insulators, glass.
1,259 insulators, porcelain.
336 insulator brackets.
12 magnifying glasses.
5 pantographs.
10 yards blue process paper.
155 yards cross-section paper.
120 yards brown drawing paper.
100 yards white drawing paper.
55 pounds manila paper.
287 pounds petroleum paper.
6 lead pencils.
104 crow-quill pens.
104 lithographing pens.
92 mapping pens.
13 German-silver protractors.
6 ivory protractors.
54 wooden protractors.
18 rubbers, elliptical.
10 rubbers, sponge.
6 rules, measuring.
1 pound sealing wax.
12 splines.
36 spline weights.
5 stamps, letters and figures.
18 seal stamps.
1 set steel stamps, figures.
5 steel ordnance stamps.
12 rubber T squares.
240 thumb tacks.
5 centering thumb tacks and pins.
134 yards tracing cloth.
6 pairs trestles.
6 rubber triangles.
12 triangular scales, wood.
50 zincs, with connectors for gravity battery.

LABORATORY MATERIAL.

189 pounds sulphuric acid.
87 gallons alcohol.
9 chemical balances.
9 air drying baths.
131¾ pounds beeswax.
10 pounds borax.
20 pounds camphor.
8 pounds white chalk.
25 pounds sulphate of copper.
800 pounds electropoin fluid.
25 pounds glue.
5 pounds gum arabic.
9 brass spirit-lamps.
10 pounds lye.
200 pounds refined niter.
500 pounds laboratory paper.
50 pounds chlorate of potash.
20 pounds gum shellac.
40 pounds nitrate of strontia.
27 thermometers.
54 watch glasses.
1,321 pounds Japan wax.
9 balance weights.
10 gallons whisky.

OIL, PAINT, ETC.

390 gallons coal tar.
62 gallons Japan drier.
5 gallons liquid drier.
63¾ gallons lacquer.
7¾ pounds lampblack.
968 pounds white lead.
12 pounds extract of logwood.
12 pounds oak graining.
44 quarts anti-corrosive oil.
13 gallons castor oil.
½ pound clock oil.
75½ gallons cosmoline oil.
3,756 pounds harness oil.
144¾ gallons kerosene oil.
10 gallons lard oil.
283½ gallons boiled linseed oil.
136¼ gallons raw linseed oil.
95 gallons neat's-foot oil.
1,091½ gallons neutral oil.
815⅜ gallons sperm oil.
1 can of paint.
1,137 pounds black paint.
2,588 pounds brown paint.
310 pounds lead-color paint.
2,341 pounds olive paint.
87 pounds 3.2-inch gun paint.
455 pounds 3.2-inch gun carriage paint.

10 pounds red paint.
43 pounds vermilion paint.
10 pounds white paint.
55 pounds putty.
20 pounds sienna.
12 boxes stencil paste.
504 gallons turpentine.
20 pounds umber.
25 gallons asphaltum varnish.
20 gallons coach varnish.
10 gallons copal varnish.
10 gallons shellac varnish.

MISCELLANEOUS.

14 anchors.
356 arm chests.
413 powder barrels.
8 boxes for cleaning material.
5 tin cans.
8 carboys.
15 chamois-skin sword cases.
16 tin cups, four quarts.
1 demijohn.
111 instruction books.
200 feet garden hose.
4 boat oars.
15 pounds rubber.
1 artillery wagon.
1 water barrel for artillery wagon.
867 pounds wheel grease.
26 wheel-grease cans.
26 wheel-grease can knives.
1 wheel-grease syringe.

INSPECTING INSTRUMENTS.

1 caliper, diameter.
11 steel caliper arms.
1 set fixtures for suspending wood caliper arms.
1 set fuse seat thread gauge, 3.2-inch shrapnel.
200 pressure-gauge gas-checks.
2 star-gauge land guides.
1 set measuring and fixed points for exterior diameter.
1 set measuring and fixed points for interior diameter.
1 micrometer for surface lengths.
19 pressure gauges.
3,300 pressure-gauge cylinders.
1,500 pressure-gauge gas-checks.
5 pressure-gauge housings.
300 pressure-gauge pieces, copper.
2 pressure-gauge seat plugs.
100 pressure-gauge rings.
20 pressure-gauge springs.
1 set pressure-gauge seat tools.
200 pressure-gauge washers.

1 set recess gauges.
1 set ring gauges.
1 set ring gauge bands.
2 ring gauges for setting star gauge.
2 star gauges.
1 star gauge rest.
2 sets star gauge measuring points.
1 step gauge with three blades.
8 thickness gauges.
2 trolleys for steel caliper arms.

TOOLS.

7 anvils.
100 leather aprons.
6 augers.
3 auger handles.
38 axes.
68 ax handles.
30 brad awls.
8 peg awls.
3 scribing awls.
9 seat awls.
473 stitching awls.
7 stub awls.
25 patent awl handles.
159 plain awl handles.
14 assorted bits.
36 auger bits.
2 sets auger bits.
5 bits for brace.
5 braces.
14 battery brushes.
7 counter brushes.
7 dusting brushes.
18 fitch brushes.
245 paint brushes.
97 sash brushes.
9 stencil brushes.
2 varnish brushes.
6 whitewash brushes.
2 iron water buckets.
6 wooden water buckets.
2 buttresses.
9 calipers.
10 chains, engineer, 100 feet long.
18 chalk lines.
31 cold chisels.
9 chisels, cold iron.
11 chisels, hot iron.
4 firmer chisels.
2 sets firmer chisels.
12 framing chisels.
6 chisel handles.
18 claw tools.
25 clinching irons.
3 coal bags.

105 compasses.
20 prismatic compasses.
1 countersink.
29 wooden creasers.
12 crowbars.
11 die stocks and dies.
2 dustpans.
41 edge tools.
584 files.
78 file handles.
7 flatters.
5 fullers.
4 glass funnels.
2 tin funnels.
2 gauges.
22 draw gauges.
1 splitting gauge.
1 glue pot.
9 gouges.
5 grindstones, with arbors and cranks.
11 assorted hammers.
14 claw hammers.
45 hand hammers.
37 riveting hammers.
27 saddlers' hammers.
5 set hammers.
46 shoeing hammers.
20 sledge hammers.
30 hammer handles.
3 handbarrows.
20 hardies.
10 hatchets.
3 hatchet handles.
6 hoes.
20 holdfasts.
24 assorted knives.
5 drawing knives.
25 half-round knives
21 head knives.
2 round knives.
78 shoe knives.
96 shoeing knives.
23 splitting knives.
29 toe knives.
1 lawn mower.
20 hand levels.
12 spirit levels.
10 leveling rods.
24 mallets.
10 sets marking pins.
12 marking pots.
9 mauls.
26 maul handles.
1 measuring rod.
4 collar needles.
512 glovers' needles.

4,981 harness needles.
12 sail needles.
63 nippers.
21 oilers, brass.
18 oil cans.
8 oil droppers.
22 oilstones.
2 pans.
12 planes.
18 pickaxes.
22 pickax handles.
6 paring pincers.
61 shoeing pincers.
17 pliers.
6 points for spring punch.
4 pokers.
7 pricking carriages.
25 pricking wheels.
13 pritchels.
5 assorted punches.
7 center punches.
2 driving punches.
3 forepunches and creasers.
74 hand punches.
20 nail punches and clinch knives.
5 revolving punches.
17 round punches.
10 small steel punches.
49 spring punches.
10 square punches.
9 punching blocks, lead.
11 rakes.
792 shoeing rasps.
13 wood rasps.
5 riveting irons.
25 rivet sets.
58 rules, 2 feet.
43 sandstones.
20 sash tools.
5 cross-cut saws.
9 handsaws.
6 rip saws.
6 saw blades.
1 saw-set.
2 scales and weights.
4 scissors.
48 screw-drivers.
35 screw-drivers, barbette carriage.
2 scythes.
4 scythe snaths.
11 scythe stones.
1 sewing palms.
49 shears.
1 shoeing boxes.
41 shovels.
12 slickers.

19 spades.
4 spokeshaves.
10 steel squares.
3 trying squares.
2 sets stencils, letters and figures.
15 stitching clamps.
18 stitching horses.
1 straightedge.
7 syringes.
13 steel tapes, 100 feet long.
7 tapelines.
19 tap screws.
24 thimbles.
13 ticklers.
58 tongs.
24 tool bags.
12 tool boxes.
6 tool chests.
13 bench vises.
2 forge vises.
6 hand vises.
3 table vises.
87 double wrenches, barbette carriage.
12 key wrenches.
12 monkey wrenches.
10 nut wrenches.
38 screw wrenches.
3 small wrenches for forge.
8 tap wrenches.

APPENDIX 4.

Statement of ordnance, ordnance stores, etc., distributed to the militia from July 1, 1891, to June 30, 1892, under sections 1661 and 1667, Revised Statutes United States.

CLASS I.

2 3-inch wrought-iron guns.
6 Gatling guns, 10 barrels, long, caliber .45, model 1883.

CLASS II.

2 carriages and limbers for 3-inch guns.
6 carriages and limbers (metallic) for Gatling guns, caliber .45.
4 caissons and limbers, complete, for 3.2-inch guns.
1 combined forge and battery wagon.

CLASS III.

8 fuse cutters.
8 fuse gouges.
1 fuse wrench.
4 gunners' haversacks.
10 gunners' gimlets.
6 gunners' pincers.
34 handspikes, trail.
16 lanyards.
12 priming wires.
11 prolonges.
4 poles, spare.
4 pole pads.
4 pairs pole straps.
2 pole yokes, field.
9 paulins, 12 by 15 feet.
8 pendulum hausses.
6 pendulum hausse pouches.
20 sets artillery harness, two horses, lead.
20 sets artillery harness, two horses, wheel.
2 sponge buckets, iron.
2 tar buckets, iron.
8 sponges and rammers, 6-pounder gun.
48 sponges and rammers, 3-inch rifle.
16 sponge covers, 3-inch rifle.
20 thumbstalls.

2 tube pouches.
4 tow-hooks.
6 tompions.
10 vent covers.
8 vent punches.
6 worms and staves.
12 water buckets.
30 whips, artillery.
6 wheels, artillery.
13 bridles, artillery, near horse.
20 halters, artillery.
6 muzzle sights, 3-inch rifle.
3 keys for muffs.
6 lanterns, globe.
8 sponge staves, 3-inch gun.
8 linchpins, No. 1.
8 linchpin washers, No. 1.
1 cap square for 6-pounder carriage.
2 muzzle sights for 6-pounder gun.
3 prolonge hooks.
4 lock chain and hooks.

IMPLEMENTS FOR GATLING GUNS.

16 feed magazines, Accles.
8 feed guides, Bruce.
2 hoppers.

Classes IV and V.

20 10-inch shell.
100 3.2-inch shell.
25 3-inch Hotchkiss shell, time fuse.
250 3-inch Hotchkiss shell, percussion fuse, fully prepared.
50 3-inch Hotchkiss case shot.

Class VI.

3,527 Springfield rifles, model 1884.
40 Springfield cadet rifles, model 1884.
10 Springfield officers' rifles, model 1884.
154 Springfield carbines, model 1884.
200 Colt's revolvers, caliber .45.
9 officers' swords and cases.
26 sabers, cavalry officers, and cases.
143 sabers, light artillery.
120 sabers, light cavalry.
157 swords, non-commissioned officers'.
119 swords, musicians'.
710 bayonets.
25 navy cutlasses.
24 hospital corps knives and scabbards.

APPENDAGES.

1,895 headless shell extractors.
2,457 screw-drivers, model 1879.

2,429 wooden wiping-rods.
184 jointed ramrods.
376 tumbler punches.
103 spring vises.

HORSE EQUIPMENTS.

313 bridles, curb, cavalry.
1 pair curb straps.
26 cruppers.
334 saddles, leather covered, cavalry.
49 saddle blankets, artillery.
169 saddle blankets, cavalry.
19 saddle cloths, general staff officers.
3 saddle cloths, officers of cavalry.
6 saddle cloths, officers of infantry.
20 saddle cloths, officers'.
48 saddle cloths, hair.
1 housing for brigadier-general's saddle.
16 housings for general officer's saddle.
1 pair spurs and straps, officers'.
167 pairs spurs and straps.
25 pairs spur straps.
105 horse brushes.
138 nose bags.
105 horse covers.
20 lariats.
183 links with straps.
41 stirrups and hoods.
22 hair girths.
121 surcingles.
1 stirrup socket and guidon.
1 throat strap.

INFANTRY EQUIPMENTS.

2,613 bayonet scabbards.
4,404 blanket bags.
100 blanket-bag hooks.
6,313 pairs blanket-bag shoulder straps.
6,354 pairs blanket-bag coat straps.
3,002 canteens and straps.
2,250 canteen straps.
1,393 cartridge belts and plates.
200 cartridge-belt plates.
3,202 cartridge boxes.
3,555 haversacks.
4,220 haversack straps.
6,088 gun slings.
229 frogs, sliding, non-commissioned officers'.
3,036 waist belts and plates.
3,000 waist belts.
78 waist belt plates.
192 waist belts and plates, non-commissioned officers'.
21 officers' black leather sword belts.
305 meat cans.

1,300 tin cups.
1,000 knives.
1,000 forks.
1,000 spoons.

ARTILLERY ACCOUTERMENTS.

413 artillery saber belts and plates.
50 light artillery knapsacks.

CAVALRY EQUIPMENTS.

239 carbine slings and swivels.
113 carbine boots and straps.
40 carbine boots.
105 carbine scabbards.
155 canteens and straps.
215 pistol holsters.
140 pistol cartridge pouches (cap pouches).
296 saber belts and plates.
270 saber knots.
210 saber straps.
55 saber attachments.
15 sword belts and plates, officers', black leather.
1 scabbard for saber.

CLASS VIII.

500 blank cartridges, 12-pounder gun.
2,200 blank cartridges, 3-inch rifle.
100 blank cartridges, 3.2-inch rifle.
1,525,000 rifle ball cartridges, caliber .45.
605,000 rifle ball cartridges, caliber .50.
149,000 carbine-ball cartridges, caliber .45.
372,000 rifle and carbine blank cartridges, caliber .45.
17,500 rifle blank cartridges, caliber .50.
10,000 revolver ball cartridges, caliber .45.
1,000 revolver blank cartridges, caliber .45.
127,000 lubricated rifle bullets, caliber .45.
130,000 round balls (140 grains), caliber .45.
16,000 carbine bullets, caliber .45.
30,000 primed cartridge shells (rifle), caliber .45.
5,000 revolver bullets, caliber .45.
420,000 cartridge primers.
23,000 friction primers.
50 Bormann fuses.
50 fuse plugs, time.
200 fuse plugs, wood, 10-inch mortar shell.
50 cartridge bags, 10-inch.
300 cartridge bags, 3-inch rifle.
200 cartridge bags, 6-pounder gun.
400 pounds cannon powder.
200 pounds mortar powder.
300 pounds mammoth powder.
1,300 pounds small arms powder.

MISCELLANEOUS.

99 arm chests.
6 arm racks, portable, for rifle.
2 arm racks, portable, for carbine.
3 arm-rack keys.
14 boxes cleaning material.
1 set bench reloading tools.
6 chamois-skin cases.
745 centers for paper targets.
966 cloth silhouettes.
4,690 paper silhouettes.
4 sets hand reloading tools.
850 marksman's buttons.
80 marksman's pins.
179 sharpshooters' badges.
122 silver bars for badges.
50 sand glasses.
10 streamers with halyards.
20 wire scratch brushes.
7 targets for gallery practice, 75 feet range.
2 targets for gallery practice, 50 feet range.
8 sets marking rods, disks, and brushes.
164 steel frames for targets.
24 signal flags.
200 yards cloth for targets.
8 Laidley revolving targets, 6 by 6 feet.
4 Laidley revolving targets, 6 by 12 feet.
96 Laidley target frames, 6 by 6 feet.
6 Laidley target frames, 6 by 12 feet.
1,788,250 pasters.
2,945 paper targets.
2 Brinton targets, 6 by 6 feet.
2 Brinton targets, 6 by 12 feet.
24 Brinton target frames, 6 by 6 feet.
24 Brinton target frames, 6 by 12 feet.
5 revolving targets, Texas.
2 primer extracting tools.
2 primer inserting tools.
2 shell scrapers.
2 powder charging tools.
2 resizing gauges.

PARTS OF SPRINGFIELD RIFLE, CALIBER .45.

55 bayonet clasps.
285 bayonet-clasp screws.
10 bayonet-clasp stop screws.
80 bridles.
430 bridle screws.
76 breechblocks.
17 breechblock caps.
137 breechblock cap screws.
53 breech screws.
10 butt plates.

25 butt-plate screws.
45 cam latches.
905 cam-latch springs.
40 cam latches, complete.
1,341 extractors.
2,355 ejector springs.
2,585 ejector-spring spindles.
322 front sights.
250 front-sight covers.
365 front-sight pins.
4,650 firing pins.
800 firing-pin screws.
55 guards, complete.
12 guard plates.
150 guard-bow swivels.
200 guard-bow swivel screws.
66 hinge pins.
10 hinge-pin studs.
165 hammers.
191 lower bands.
77 locks, complete.
35 lock plates.
140 leaf slide binding screws.
10 leaf-slide stop pins.
35 mainsprings.
242 mainspring swivels.
100 mainspring-swivel rivets.
15 movable base springs.
5 pistol grips.
709 rear sights, complete.
60 rear-sight leaves.
60 rear-sight joint pins.
25 rear-sight slides.
35 rear-sight screws, front.
35 rear-sight screws, rear.
247 ramrods.
650 sears.
470 sear screws.
10 sear-spring screws.
550 side screws.
100 side-screw washers.
495 stocks, complete.
115 stocks (wood part).
850 tumblers.
1,074 tumbler screw.
320 tang screws.
10 tips.
10 tip screws.
5 thumb pieces.
37 triggers.
12 trigger screws.
516 upper bands, complete.
164 windage screws.
24 windage head screws.
24 windage head screw pins.

150 rear-sight base screws.
50 rear-sight slide spring rivets.
250 front and rear base screws (slide recoil stud).

PARTS COLT'S REVOLVER, CALIBER .45.

25 trigger screws.
50 mainspring screws.
50 bolts.
2 quarts cosmoline oil.

Appendix 5.

Statement of ordnance, ordnance stores, etc., distributed to colleges, from July 1, 1891, to June 30, 1892, under section 1225, Revised Statutes United States, as amended by act approved September 26, 1888.

Class I.

28 3-inch wrought-iron rifled guns, model 1861.
6 3.2-inch breech-loading rifles.

Class II.

28 carriages and limbers for 3 inch guns.
9 carriages and limbers for 3.2-inch guns.
4 caissons and limbers for 3.2-inch guns.

Class III.

4 gunners' gimlets.
42 gunners' haversacks.
4 gunners' reamers.
29 handspikes, trail.
66 lanyards.
8 lanyards, new pattern.
37 priming wires.
30 paulins, 12 by 15 feet.
8 paulins, 11 by 11 feet.
15 pendulum hausses.
15 pendulum-hausse seats.
15 pendulum-hausse pouches.
60 sponges and rammers, 3-inch.
5 sponges and rammers, jointed for bore, 3.2-inch guns.
9 short sponges and rammers, combined, for chamber for 3.2-inch guns.
64 sponge covers, 3-inch.
4 sponge covers, 6-pounder.
16 sponge covers, 3.2-inch.
1 combination screw-driver.
66 thumbstalls.
34 tube pouches.
8 primer pouches.
30 tompions.
32 vent covers.
4 vent punches.
1 breech sight, 3.2-inch gun.
2 front sights, 3.2-inch gun.
2 tompions, 3.2-inch gun.
2 vent covers, spring, 3.2-inch.
8 sets artillery harness, two horses, wheel.
8 sets artillery harness, two horses, lead.

CLASS VI.

3,141 Springfield cadet rifles, model 1884.
40 Springfield carbines, model 1884.
27 swords, non-commissioned officers'.

CLASS VII.

APPENDAGES.

3,110 headless shell extractors.
3,110 screw-drivers, model 1879.
3,110 wooden wiping rods.
40 jointed ramrods.
623 tumbler punches.
166 spring vises.
2,908 bayonet scabbards.
3,002 cartridge boxes.
2,964 waist belts and plates.
62 waist belts.
25 frogs, sliding, non-commissioned officers'.
23 waist belts and plates, non-commissioned officers'.
40 saber knots.
315 gun slings.
40 carbine slings and swivels.

CLASS VIII.

200 blank cartridges, 12-pounder gun.
100 blank cartridges, 6-pounder gun.
3,400 blank cartridges, 3-inch rifle.
100 blank cartridges, 3.2-inch rifle.
1,300 rifle ball cartridges, caliber .45.
108,400 carbine ball cartridges, caliber .45.
1,000 revolver ball cartridges, caliber .45.
61,000 rifle and carbine blank cartridges, caliber .45.
10,900 carbine bullets (405 grains).
53,000 round balls, caliber .45 (140 grains).
106,000 cartridge primers.
11,400 friction primers.
125,500 pasters.
1,450 paper targets.
100 centers for paper targets.
825 pounds small-arms powder.

MISCELLANEOUS.

166 arm chests.
9 sets hand reloading tools.
4 bullet molds (4 balls).
45 pounds lubricant.
1 melting ladle, 7-inch.
1 pouring ladle, 2-inch.
200 targets for gallery practice, 50-feet range.
3 sets shot marks and staves.
1 rifle resizing die for breech-reloading tool.

APPENDIX 6.

Statement of ordnance stores issued to the Executive Departments during the year ended June 30, 1892, under the provisions of the act of March 3, 1879.

TO THE TREASURY DEPARTMENT.

5	Colt's revolvers.
5	pistol holsters.
5	waist belts and plates.
120	revolver ball cartridges.
1,200	carbine ball cartridges.
1	box of cleaning materials.

APPENDIX 7.

Report of action taken under the act of March 3, 1881, during the fiscal year ended June 30, 1892.

NOTE.—No purchases or sales have been made during the year.

APPENDIX 8.

SHOWING THE STATIONS AND DUTIES OF THE OFFICERS OF THE ORDNANCE DEPARTMENT ON OCTOBER 1, 1892.

Rank and name.	Duty and station.	Address.
BRIGADIER-GENERAL.		
1. D. W. Flagler	Chief of Ordnance	Washington, D. C.
COLONELS.		
1. J. M. Whittemore	Commanding United States Powder Depot	Dover, N. J.
2. A. R. Buffington	Commanding the Rock Island Arsenal	Rock Island, Ill.
3. A. Mordecai	Commanding the Springfield Armory	Springfield, Mass.
LIEUTENANT-COLONELS.		
1. F. H. Parker	Commanding the Watervliet Arsenal and president of the Board for Testing Rifled Cannon, etc.	West Troy, N. Y.
2. J. P. Farley	Commanding the Frankford Arsenal	Philadelphia, Pa.
3. L. S. Babbitt	Commanding the Benicia Arsenal	Benicia, Cal.
4. W. A. Marye	Commanding the Fort Monroe Arsenal	Fort Monroe, Va.
MAJORS.		
1. I. Arnold, jr	Commanding the Columbia Arsenal	Columbia, Tenn.
2. C. Comly	Commanding the New York Arsenal, president of the Ordnance Board, member of Board for Testing Rifled Cannon, etc., member of the Board of Ordnance and Fortification, and member of Board Government Exhibit at the World's Columbian Exposition, Chicago, Ill.	Governors Island, New York City. P. O. box 1449.
3. J. R. McGinness	Commanding the Kennebec Arsenal	Augusta, Me.
4. F. H. Phipps	Commanding the Allegheny Arsenal	Pittsburg, Pa.
5. J. W. Reilly	Commanding the Watertown Arsenal and member of Board for Testing Rifled Cannon, etc.	Watertown, Mass.
6. J. A. Kress	Commanding the St. Louis Powder Depot	Jefferson Barracks, Mo.
7. C. E. Dutton	Commanding the San Antonio Arsenal and chief ordnance officer Department of Texas.	San Antonio, Tex.
8. J. G. Butler	Commanding the Augusta Arsenal	Augusta, Ga.
9. C. Bryant	On duty at the Watervliet Arsenal	West Troy, N. Y.
10. A. L. Varney	Commanding the Indianapolis Arsenal	Indianapolis, Ind.
CAPTAINS.		
1. J. E. Greer	On inspection duty at the Builders' Iron Foundry, Providence, R. I.	22 Codding street, Providence, R. I.
2. J. Pitman	On duty at the Frankford Arsenal	Philadelphia, Pa.
3. C. Shaler	Principal assistant in the Ordnance Bureau	Washington, D. C.
4. H. Metcalfe	On sick leave	Cold Spring, N. Y.
5. C. S. Smith	On duty in the office of the Chief of Ordnance.	Washington, D. C.
6. S. E. Blunt	On duty at the Springfield Armory	Springfield, Mass.
7. F. Heath	Commanding the Sandy Hook Proving Ground, member of Board for Testing Rifled Cannon, etc., and member of the Ordnance Board.	Governors Island, New York City. P. O. box 1449.
8. D. M. Taylor	On duty at the Springfield Armory and member of the Board for Testing Range and Position Finders.	Springfield, Mass.
9. D. A. Lyle	On inspection duty at the Midvale Steel Works, Nicetown, Philadelphia, Pa., and member of Board on Life-Saving Apparatus, etc., under the Secretary of the Treasury.	P. O. box 1606, Philadelphia, Pa.

SHOWING THE STATIONS AND DUTIES OF THE OFFICERS OF THE ORDNANCE DEPARTMENT ON OCTOBER 1, 1892—Continued.

Rank and name.	Duty and station.	Address.
CAPTAINS—continued.		
10. J. Rockwell, jr.	On duty at the Watervliet Arsenal	West Troy, N. Y.
11. J. C. Ayres	Commanding the Omaha Ordnance Depot and chief ordnance officer Department of the Platte.	Omaha, Nebr.
12. M. W. Lyon	On duty at the Rock Island Arsenal	Rock Island, Ill.
13. C. W. Whipple	On duty in the office of the Chief of Ordnance.	Washington, D. C.
14. A. H. Russell	In charge of ordnance exhibit World's Columbian Exposition.	Washington, D. C.
15. R. Birnie	On duty in the office of the Chief of Ordnance.	Washington, D. C.
16. I. MacNutt	On inspection duty at the Bethlehem Iron Works, South Bethlehem, Pa.	South Bethlehem, Pa.
17. C. C. Morrison	On duty at Watervliet Arsenal and recorder of Board on Ordnance and Fortification.	West Troy, N. Y.
18. F. Baker	On duty at the Frankford Arsenal.	Philadelphia, Pa.
19. O. B. Mitcham	On inspection duty at the Midvale Steel Works, Nicetown, Philadelphia, Pa.	P. O. box 1606, Philadelphia, Pa.
20. H. D. Borup	Awaiting orders	Sing Sing, N. Y.
21. L. L. Bruff	Instructor of ordnance and gunnery, U. S. Military Academy.	West Point, N. Y.
22. C. H. Clark	Commanding the Vancouver Barracks Ordnance Depot and chief ordnance officer Department of the Columbia.	Vancouver, Wash.
23. William Crozier	Member of the Ordnance Board	Governors Island, New York City. P. O. box 1449.
24. W. B. Gordon	On inspection duty at West Point Foundry, Cold Spring, N. Y., and inspector of pneumatic dynamite guns.	Cold Spring, N. Y.
25. F. E. Hobbs	On duty at the Watervliet Arsenal	West Troy, N. Y.
FIRST LIEUTENANTS.		
1. D. A. Howard	On duty at the Watervliet Arsenal	West Troy, N. Y.
2. S. E. Stuart	On inspection duty at the Bethlehem Iron Works, South Bethlehem, Pa	South Bethlehem, Pa.
3. J. W. Benét	On duty at the Frankford Arsenal	Philadelphia, Pa.
4. W. W. Gibson	On duty at the Watertown Arsenal	Watertown, Mass.
5. E. B. Babbitt	Assistant instructor of ordnance and gunnery, U. S. Military Academy.	West Point, N. Y.
6. O. M. Lissak	On duty at the Benicia Arsenal	Benicia, Cal.
7. B. W. Dunn	On duty at the Watertown Arsenal	Watertown, Mass.
8. John T. Thompson	On duty at the Rock Island Arsenal	Rock Island, Ill.
9. Charles B. Wheeler	On duty at the Sandy Hook Proving Ground and member of Board for Testing Rifled Cannon, etc.	Governors Island, New York City. P. O. box 1449.
10. F. P. Peck	On duty at the Sandy Hook Proving Ground.	Governors Island, New York City. P. O. box 1449.
11. W. S. Peirce	On duty at the Watervliet Arsenal	West Troy, N. Y.
ORDNANCE STOREKEEPERS. CAPTAINS.		
1. A. S. M. Morgan	On duty at the Allegheny Arsenal	Pittsburg, Pa.
2. W. H. Rexford	On duty at the Springfield Armory, with rank of major.	Springfield, Mass.
3. M. J. Grealish	On duty at the Rock Island Arsenal	Rock Island, Ill.
4. V. McNally	On duty in the office of the Chief of Ordnance.	Washington, D. C.

APPENDIX 9.

REPORT OF THE BOARD OF OFFICERS CONSTITUTED BY GENERAL ORDER NO. 136, HEADQUARTERS OF THE ARMY, ADJUTANT-GENERAL'S OFFICE, NOVEMBER 24, 1890, TO SELECT MAGAZINE ARMS FOR THE U. S. MILITARY SERVICE.

(22 plates.)

OFFICE OF THE BOARD ON MAGAZINE ARMS,
Army Building, New York City, August 19, 1892.

SIR: I have the honor to submit herewith the report of the Board on Magazine Arms.

A gun, upon the system recommended, is to-day sent by express.

The journal of proceedings, with drawings and descriptions of the guns submitted for examination and synopsis of their trials, will be forwarded by the recorder of the board in a few days, probably by the 25th instant.

Very respectfully, your obedient servant,

ROBT. H. HALL,
Lieut. Col. Sixth Infantry, President of the Board.

OFFICE OF THE BOARD ON MAGAZINE ARMS,
Army Building, New York City, August 19, 1892.

The board was originally constituted by General Orders No. 136, Headquarters of the Army, Adjutant General's Office, November 24, 1890; changes were subsequently made in its composition by the following Special Orders from Army Headquarters, viz: No. 289, December 11, 1890; No. 153, July 6, 1891; No. 284, December 7, 1891; and No. 17, January 21, 1892.

The board met at the Army Building, New York City, December 16, 1890, and has since continued in session from time to time whenever any arms were on hand ready for trial or there was other matter pending to engage its attention. The period for the original submission of guns was limited by the Secretary of War to July 1, 1892, though arms withdrawn for correction might in the discretion of the board be received later; of this latter privilege advantage has been fully taken.

The original order required the board "to consider and recommend a suitable magazine system for rifles and carbines for the military service."

Subsequent instructions (see in record of proceedings those for November 3, 1891) required an opinion as to the merits of the caliber .30 Springfield single-loader and its ammunition, and also (see in record of proceedings those for June 30, 1892) an "opinion as to the relative merits of a magazine arm and a single-loader for use in the United States service."

The first of the above-mentioned opinions was submitted soon after it was required and will be found in the proceedings of the board for November 3, 1891, and a supplementary report was rendered July 28, 1892. (See proceedings for that day.) Upon the other matters the board now reports as follows: In all fifty-three guns have been subjected to trial, including, besides the product of different private inventors, both American and foreign, the small arms officially adopted for the armies of the following countries, viz: Austria-Hungary, Belgium, Denmark, England, France (for cavalry), Germany, Japan, Portugal, Roumania, Russia, and Switzerland.

Each of the different magazine guns examined can be placed in one of two general classes, dependent upon the manner in which their fire can be delivered.

First. Those which, while the magazine is charged, can not be used as single-loaders. These arms should more properly be termed repeating guns.

Second. Those in which the magazine can be charged and then held in reserve while single fire is delivered, magazine fire being, however, available at any moment.

Therefore guns of the first class can be employed as single-loaders only when the magazine is empty; those of the second class, when it is either empty or loaded.

The small arms of Austria-Hungary, Germany, and Roumania are typical of the first class; for them the cartridges are habitually carried in the ammunition trains, and by the soldier in packets of five, the packet being introduced bodily into the magazine.

Typical of the second class are the small arms of Denmark, England, Switzerland, and the improved Mauser gun. With the best developed of this class the cartridges are carried by the soldier, both singly and in packets, the latter being employed to facilitate rapid charging of the magazine, though not essential thereto.

This classification compelled the board to consider not merely the mechanical features of the guns it has examined, but also their merits and defects as an armament; and from such consideration the board is of the opinion that magazine systems of the second class are more "suitable" for our service than those of the merely repeating type.

A number of guns of both classes were subjected to supplementary examination and test, the Springfield .30 single-loader being introduced as a standard of comparison.

These and the previous trials showed to the entire satisfaction of the board that the bolt system of breech closure as developed in the last few years, and particularly for arms of the reduced caliber, is superior as a single-loader, in ease of manipulation, facility of loading, and rapidity of fire, to an arm on the block system like the Springfield, and has the additional advantage that without sacrificing any of its features it is also adaptable to use as a magazine arm.

Added to the differences in breech mechanism brought before the board, there has been a further complication of the subject incident

to the cartridge employed; these have had flanges like those at present in our service, while others have been flangeless with cannelured heads.

Attendant upon the manufacture of the latter and their exact adjustment to the guns in which they might be used are many difficulties not experienced in the manufacture and use of the flanged shell.

Recognizing all these conditions, the board has unanimously arrived at the conclusion that an arm showing itself to be an efficient single-loader, a rapid magazine arm, holding meanwhile that magazine in reserve, with a cut-off plainly indicating to the officers which class of fire is being delivered, and a system adaptable to either a headed or a flangeless shell, was the most "suitable" for our military service of all examined.

Such a system is found in the Krag-Jörgensen guns as improved and ultimately submitted to the board.

Two of these guns were finally examined, one taking a flanged, the other a rimless shell. They appear to be of equal merit, but on account of the difficulties that might possibly attend the use of the latter class of cartridge the board recommends the adoption of the gun for the flanged head, known on its record as Krag-Jörgensen No. 5.

This arm is a decided modification of and an improvement upon the weapon of the same name now in use in Denmark.

As to the "relative merits of a magazine arm and a single-loader for use in the United States service," the board deems that its opinion has been already expressed in the previous remarks; but, that no doubt may exist as to its position, the board adds that it considers such an arm as this Krag-Jörgensen No. 5, which is capable in a high degree of both single-loading and magazine fire, to be vastly superior for use in the United States service to any weapon adapted to single-loading fire only.

ROBT. H. HALL,
Lieut. Col. Sixth Infantry.
J. P. FARLEY,
Lieut. Col., Ord. Dept., U. S. A.
H. B. FREEMAN,
Major Sixteenth Infantry.
S.E. BLUNT,
Captain, Ord. Dept., U. S. A.
GEO. S. ANDERSON,
Captain, Sixth Cavalry.

ORDNANCE OFFICE,
Washington, September 10, 1892.

Respectfully forwarded to the Secretary of War.

The within report was made by the board convened by General Orders 130, dated Headquarters of the Army, November 24, 1890.

This board commenced its sessions December 16, 1890.

Inventors were at once invited to present arms to the board, and all needful information from the board and all practicable assistance by this Department in preparing arms was furnished to inventors for this purpose.

As you are aware, at the end of a year and two months' time it was found that in consequence of delay on the part of inventors in presenting their arms little progress had been made; the work of the board

was being unduly protracted; there was little prospect that the board would ever conclude its labors and arrive at a new arm, and in the meantime this country was years behind other nations in the adoption of a modern type of small-caliber, high-velocity magazine arm and was suffering in military reputation therefrom.

It was then decided, to enable the board to end its labors at all and arrive at a new arm, it was necessary to fix some time after which new arms would not be received by this board, and to then permit the board to conclude its labors.

On January 25, 1892, therefore, you fixed this limit of time at June 1, 1892, which limit it was thought would give all inventors ample time, and inventors were duly notified.

Subsequently this time was extended to July 1, 1892, but with instructions that inventors should be informed that no further extension would be granted.

This report has been made after an examination of fifty-three guns presented by American and foreign inventors, many of the guns being the regulation arm of the principal military powers of Europe.

The arms were all subjected to a uniform test, which was careful and exhaustive.

The board has selected the model known as Krag-Jörgensen No. 5, as possessing the best magazine system presented and as a suitable and satisfactory system to be adopted for the United States military service.

This arm can also be used as a single-loader, and the board also finds that as a single-loader it is the best arm presented to the board, and is a suitable and satisfactory arm to be adopted for the United States military service.

The board tested the Springfield arm of reduced caliber as a single-loader and reports adversely to its use.

It is recommended, therefore, that the Secretary of War approve the selection of the Krag-Jörgensen system for trial with the view to adoption in the military service of the United States as recommended by the board.

Questions of proper caliber, ammunition, sighting, rifling, and ramrod, and some minor details to be applied to this system remain to be determined, and authority is asked for this Department to organize a board of ordnance officers to be charged with determining these points at once.

D. W. FLAGLER,
Brig. Gen., Chief of Ordnance.

HEADQUARTERS OF THE ARMY,
Washington, September 15, 1892.

Respectfully returned to the Acting Secretary of War, fully concurring in the recommendation of the Chief of Ordnance in the preceding indorsement, dated September 10, 1892.

Early action is desirable, in order that the Army may be supplied without unnecessary delay with the most approved firearm. The arm selected by the board undoubtedly fulfills all the essential conditions required at the present time in such a weapon.

J. M. SCHOFIELD,
Major-General, Commanding.

WAR DEPARTMENT,
September 15, 1892.

Approved as recommended by the Chief of Ordnance and the Major-General commanding. Let the board be dissolved.

L. A. GRANT,
Acting Secretary of War.

(4577–'92.)

PART I.—*Proceedings of the Board on Magazine Arms.*

The board of officers convened by virtue of the following orders:

GENERAL ORDERS, No. 136. } HEADQUARTERS OF THE ARMY, ADJUTANT-GENERAL'S OFFICE,
Washington, November 24, 1890.

By direction of the Secretary of War a board of officers will assemble at the Army Building New York City, on the 16th day of December, 1890, or as soon thereafter as practicable, to consider and recommend a suitable magazine system for rifles and carbines for the military service.

DETAIL FOR THE BOARD.

Col. August V. Kautz, Eighth Infantry.
Lieut. Col. Robert H. Hall, Sixth Infantry.
Maj. George W. McKee, Ordnance Department.
Maj. Wirt Davis, Fifth Cavalry.
Capt. Henry B. Freeman, Seventh Infantry.
Capt. Stanhope E. Blunt, Ordnance Department.
The junior member will act as recorder.

All persons interested in magazine rifles are invited to appear in person before the board and submit samples under such rules as may be adopted by the board. The arms submitted must be of caliber .30, and must use the Frankford Arsenal experimental cartridge, except that the Chief of Ordnance may, in his discretion, submit such small arms, irrespective of caliber, for examination and test as he may judge will prove useful to the board.

Samples of the experimental cartridge, and any further information required by those interested, may be obtained by addressing the recorder of the board at the National Armory, Springfield, Mass.

The Chief of Ordnance will supply such information and offer such facilities to the board in the trials and experiments undertaken as may be necessary to the performance of the duty assigned it.

The board is authorized to adjourn from time to time to the National Armory, Springfield, Mass., in order to avail itself of the resources of that establishment, and upon final adjournment the members will return to their proper stations. The travel enjoined is necessary for the public service.

By command of Maj. Gen. Schofield.

CHAUNCEY MCKEEVER,
Acting Adjutant-General.

Official:
ARTHUR MACARTHUR,
Assistant Adjutant-General.

SPECIAL ORDERS, No. 289.

HEADQUARTERS OF THE ARMY,
ADJUTANT-GENERAL'S OFFICE,
Washington, December 11, 1890.

[Extract.]

* * * * * * *

17. By direction of the Secretary of War Capt. George S Anderson, Sixth Cavalry, is detailed as a member of the board of officers appointed by General Orders No. 136, November 24, 1890, from this office, to meet at the Army Building, New York City, on the 16th day of December, or as soon thereafter as practicable, to consider and recommend a suitable magazine system for rifles and carbines for the military service, vice Maj. Wirt Davis, Fifth Cavalry, hereby relieved. Capt. Stanhope E. Blunt, Ordnance Department, will continue to act as recorder of the board. Capt. Anderson will return to his station from time to time during intervals between the sessions of the board, and upon its final adjournment. Such journeys as may be required under this order are necessary for the public service.

* * * * * * *

By command of Maj. Gen. Schofield.

J. C. KELTON,
Adjutant-General.

Official:
ARTHUR MACARTHUR, Jr.,
Assistant Adjutant-General.

ARMY BUILDING,
New York City, December 16, 1890.

The board, as constituted by the above orders, met at 10 a. m. at the Army Building, New York City.

Present: All the members.

The orders convening it having been read the board entered into a discussion of the provisions of the orders, of the nature of the duties devolved upon it, and of the appropriate methods of procedure.

The recorder presented the correspondence (letters received 1 to 12, inclusive) received by him since the issue of the original order convening the board. This included letters from Mr. T. G. Bennett, president Winchester Arms Company, with reference to purchase of caliber .30 cartridges; from J. C. Fitzgerald, with reference to purchase of caliber .30 barrels; from Henry T. Allen and Charles P. Hill, applying for position as clerk to the board; from Capt. T. F. Cooke, Capt. A. C. Lewis, E. Page Davis, and the Lee Arms Company, asking for sample cartridges, and from others submitting various inquiries. The replies thereto (Letter Book, pp. 1 to 17, inclusive) were also presented. Those with reference to purchase of caliber .30 cartridges and barrels were as follows:

[Second indorsement No. 1.]

NATIONAL ARMORY,
Springfield, Mass., November 28, 1890.

Respectfully returned to the Chief of Ordnance, U. S. Army. The cartridge to be used in the trials of magazine guns has been determined upon, but their manufacture at the Frankford Arsenal has not yet been completed. Samples of the cartridge (dummies without powder) are, however, ready for issue to "those interested" as

provided by General Orders No. 136, current series, Headquarters of the Army. It is believed that every possible facility should be extended private manufacturers who expect to offer guns for examination.

The cartridges used in the tests by previous boards could readily be obtained from dealers, but in this case smokeless-powder cartridges producing the pressures found with those the board will use, are not on the market, being made only by the Ordnance Department. While dummy cartridges are useful in developing a system, live cartridges are necessary in trying it, and as the board might be relieved from the trial of imperfect guns if inventors had been able to make a few preliminary tests, it would probably be wise to supply (when manufactured) a few cartridges as asked for, which to avoid issues merely gratifying a curiosity, it is believed should be sold.

S. E. BLUNT,
Capt., Ord. Dept., U. S. A.

[First indorsement.]

NATIONAL ARMORY,
Springfield, Mass., December 13, 1890.

Respectfully referred to the Chief of Ordnance (through the commanding officer National Armory).

It is not improbable that requests similar to that within may from time to time be received by the magazine gun board; if in the opinion of the Ordnance Office it is desirable to extend all possible facilities to inventors, it is recommended that general authority be given the commanding officer National Armory to make sales of this nature upon the request of the board.

S. E. BLUNT,
Capt., Ord. Dept.

After due examination all this correspondence was approved. The recorder stated that Col. A. R. Buffington, Ordnance Department, commanding the National Armory, desired to extend to the board all the assistance that he could appropriately render and such facilities as the armory might afford for the prosecution of the tests they might undertake.

The recorder was directed to express to Col. Buffington the acknowledgments of the board.

The recorder stated that 600 of the cartridges (dummies) mentioned in the order convening the board had been sent him for distribution as there contemplated, and also that he had obtained 100 copies of that order for a similar use.

The subject of the rules and tests that should govern in the examination and trials of the guns that might be submitted was discussed at length, but pending a final determination the board adjourned until 11 o'clock a. m. the 17th instant.

ARMY BUILDING,
New York City, December 17, 1890.

The board met pursuant to adjournment.

Present: All the members.

Several gentlemen, apparently interested in magazine guns, appeared and inquired as to the board's plans of procedure and the probable duration of its sessions, but no arms were formally submitted.

After further discussion the board adopted the following rules and tests for the trial of all guns submitted under the order:

Generally these rules will govern in testing all guns submitted to the board. It may occur that certain of these tests will be modified or that others may be substituted for them, the object being to find a magazine system which will meet the requirements of the Army.

The piece to be first fired ten rounds by the exhibitor as a test of safety;

the same firing to be also a test of rapidity by one familiar with the arm. The time to be noted in the record.

The firing to be then continued, according to the rules annexed, by an employé or person designated by the board.

The Frankford Arsenal experimental cartridge to be used in all cases, except when pieces of a different caliber have been submitted in the manner provided by the order.

No persons will be admitted to the firing ground but the agents or exhibitors of the gun immediately under trial, and such other persons as may be specially invited by the board.

The handling of guns by their representatives at *any* time after the preliminary test for safety is *forbidden.*

Any arm which has been submitted to the board and entered upon the record shall remain in the hands of the board for such time as may be necessary to make drawings explanatory of its mechanism.

If the magazine system of any gun becomes disabled or unserviceable, all further tests will be discontinued, and the proprietor informed of the fact. If the gun be altered and resubmitted to the board, it will be treated as a new gun.

[Safety test: To be fired ten rounds by the exhibitor, or with a lanyard.]

REGULAR TESTS.

I.—Rapidity with Accuracy.

Piece to be fired from the shoulder at target 6 feet by 2 feet, range 100 feet, under following circumstances, cartridges disposed at will or in packets upon a table:

(*a*) Time of firing and number of hits for 20 shots; magazine to be loaded before beginning test and then held in reserve until remainder of cartridges have been fired, using gun as single loader; then firing those in magazine.

(*b*) Number of shots and hits firing for two minutes, using gun as single loader; test begun with chamber empty.

(*c*) Number of shots and hits firing for two minutes, using gun as magazine arm only; test begun with magazine empty.

Any cartridge missing fire in this or other tests to be tried with a prick punch, or opened, to ascertain cause of failure.

II.—Rapidity at Will.

Same as Test I, except that piece will be fired from the hip, without aim, at stop butt at short range; hits not considered, and time of firing for parts *b* and *c* reduced to one minute.

III.—Endurance.

(*a*) Each gun to be fired 500 continuous rounds without cleaning, using the magazine. The state of the breech mechanism to be examined at the end of every 50 rounds.

(*b*) With magazine loaded but held in reserve, each gun to be fired as a single loader 100 continuous rounds without cleaning; condition of breech mechanism and of the cartridges in magazine to be examined at conclusion of firing.

IV.—Dust.

With the mechanism closed, the piece to be exposed in the box prepared for that purpose to a blast of fine sand dust for two minutes, removed, surplus sand removed by blowing thereon and wiping with the bare hand, and then fired 20 rounds under the following conditions:

(*a*) Magazine empty when exposed. Before firing load magazine, fire balance of cartridges as a single loader, then those in magazine.

(*b*) Magazine loaded when exposed. Remove and wipe cartridges, reload and fire as above.

V.—Defective Cartridges.

Each gun to be fired once with each of the following defective cartridges: (1) Cross-filed on head to nearly the thickness of the metal. (2) Cut at intervals around the rim. (3) With a longitudinal cut the whole length of the cartridge from the rim up. A fresh piece of white paper, marked with the number of the gun, being laid over the breech, to observe the escape of gas, if any occur.

VI.—Excessive Charges.

The piece to be fired five times as a single loader with cartridges in which the charge of powder is so increased as to produce a pressure in the chamber about one-third greater than that caused by the Frankford Arsenal experimental cartridge.

VII.—Ease of Manipulation.

Facility of manipulation by members of the board.

Any gun whose breech action or magazine system fails in any of the foregoing tests will not be submitted to further tests.

SUPPLEMENTARY TESTS.*

I.—Defective Cartridges and Dust.

(*a*) As a single loader: To be fired with two defective cartridges, Nos. 1 and 2, and then to be dusted five minutes, the mechanism being in the mouth of the blowpipe and closed, but at full-cock; then to be fired 5 shots, the last two defective Nos. 1 and 2; then without cleaning to be dusted with the breech open and fired 5 shots. The piece to be freed from dust only by pounding or wiping with the bare hand.

(*b*) As a magazine arm: Same as *a* except that the cartridges for the subsequent firing will be placed in the magazine before dusting, and fired therefrom afterwards.

II.—Rust.

The breech mechanism, receiver, and magazine to be cleansed of grease, and the chamber of the barrel greased and plugged and breech action closed; the butt of the gun to be then inserted to the height of

*To be applied only to such arms as have passed through the regular tests in a manner satisfactory to the board.

the chamber in a solution of sal-ammoniac for ten minutes, exposed for two days to the open air standing in a rack, and then fired 20 rounds, loading magazine and holding it in reserve until remainder of cartridges have been fired, using gun as single loader, then firing those in magazine.

III.—Explosions in Magazine.

The liability to accidental explosion of cartridges in tubular magazines will be tested by charging the magazine, and then giving the gun a vertical jolting motion for two minutes, repeating with the magazine but half loaded.

IV.—Dismounting and Assembling.

The comparative ease and relative time required in dismounting and assembling the breech and magazine systems of the different guns will be determined.

To further determine the comparative rapidity of fire and facility of manipulation of various arms each gun will be fired 20 shots by three men to be selected by the board, loading from the cartridge-box and firing from the shoulder, with aim at an "A" target 100 yards distant. The average of the three trials to be the recorded time of firing 20 rounds. The magazine to be loaded from the cartridge-box before the start, the remainder of the cartridges to be fired away first, using the gun as a single loader, and the magazine to be emptied last.

Such additional tests or repetition of previous ones as may seem advisable will be made by the board in its discretion.

The recorder was directed to request the commanding officer National Armory to have these rules printed.

The board then adjourned until 11 o'clock a. m. the following day.

Army Building,
New York City, December 18, 1890.

The board met pursuant to adjournment.

Present: All the members.

Letters (L. R. 13, 14, 15, and 16) from W. H. Harwick, J. C. Sturgeon, Joe. V. Meigs, and J. H. Acton, asking information as to the manner of presenting guns and the requirements governing their trial, were read and filed.

The board then proceeded to Governors Island to pay their respects to Maj. Gen. Howard, commanding the Division of the Atlantic, and subsequently adjourned until 11 a. m. the 19th instant.

Army Building,
New York City, December 19, 1890.

The board met pursuant to adjournment.

Present: All the members.

By direction of the board appropriate replies (Letter Book, pp. 18, 21, 22, and 23) were sent to the communications received the previous day; also letters (Letter Book, pp. 19 and 20) to Mr. Hill and Mr. Allen, informing them that the services of a clerk would not be required

by the board for several months, and the following letter (Letter Book, p. 24) to the Chief of Ordnance:

OFFICE OF THE BOARD ON MAGAZINE ARMS,
Army Building, New York, N. Y., December 19, 1890.

SIR: I am directed by the Board on Magazine Guns to inform you that they approve the following indorsements of the recorder made before the meeting of the board, viz: second indorsement on Ordnance Office file No. 6907, with reference to sale of caliber .30 cartridges (live, not dummy). Indorsement of December 13, 1890, upon communication to the recorder from James C. Fitzgerald, of Bennett, Pa., with reference to the sale of a caliber .30 barrel. I am also directed to say that in the opinion of the board every possible facility and encouragement should be afforded inventors and the coöperation of the Government liberally extended in the endeavor to obtain a suitable magazine system for rifles and carbines.

Respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord. Dept., Recorder.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

The board directed that in intervals of any length which might occur between its sessions the recorder conduct, under the generally authority accorded him in the order convening the board, such of its correspondence as might require prompt attention and where the concerted action of the board was not necessary. No guns having been presented for trial, and the smokeless powder for use in the Frankford Arsenal experimental cartridge not having yet been received at that arsenal, it was evident that some time must elapse before any tests could be undertaken; the board therefore adjourned to meet at the Army Building, New York City, at 11 a. m., January 20, 1891.

ARMY BUILDING,
New York City, January 20, 1891.

The board met pursuant to adjournment.

Present: All the members.

The recorder laid before the board the correspondence conducted by him since the last adjournment. This included a letter (L. R., 27) from the Lee Arms Company with reference to caliber .30 barrels and letters requesting information, copies of rules governing tests, and sample (dummy) cartridges from the Sneider Arms Company, Baltimore, Md. (L. R., 18 and 23); the American Wood Powder Company, New York City (L. R., 19 and 24); J. H. Acton, Aurora, Ill. (L. R., 20); J. W. Allen, New York City (L. R., 21); the Hotchkiss Ordnance Company (L. R., 22); M. L. S. Buckner, Shelbyville, Ky. (L. R., 28); Capt. T. H. Logan, Fifth United States Infantry (L. R., 29); M. H. Durst, London, England (L. R., 30 and 32); J. H. Niemeyer, New Haven, Conn. (L. R., 31); Arthur Savage, Utica, N. Y. (L. R., 33); William H. Elliott, Brooklyn, N. Y. (L. R., 34), and W. H. Harwick, Ceres, Cal. (L. R., 35), and a letter (L. R., 17) from L. S. Harrison, Washington, D. C., submitting drawings and specifications of his invention in magazine guns.

The replies of the recorder (Letter Book, pp. 25 to 54 inclusive) to these various communications were also submitted. That to Mr. Harrison was as follows:

OFFICE OF THE BOARD ON MAGAZINE ARMS,
NATIONAL ARMORY,
Springfield, Mass., December 26, 1890.

DEAR SIR: Your letter of the 18th instant, and the accompanying drawings and specifications, have been received.

I inclose for your information copies of the order convening the board, and the rules they have adopted for the trial of the guns submitted to them. From these

you will see that drawings alone will not suffice, as the submission of the actual gun is contemplated by the order, and necessary for the execution of the prescribed tests. These drawings are at present retained awaiting your wishes with reference to their further disposition.

Respectfully,

S. E. BLUNT,
Capt., Ord. Dept., Recorder.

Mr. L. S. HARRISON,
Washington, D. C.

After consideration, all this correspondence was approved by the board. The recorder laid before the board the further action of the Ordnance Office upon the question of furnishing caliber .30 cartridges and barrels to inventors, and upon which subject the previous indorsements of the board appear in the minutes of its first day's proceedings. This action of the Ordnance Office is expressed by the following indorsements:

ORDNANCE OFFICE,
Washington, D. C., January 8, 1891.

Respectfully returned to Capt. S. E. Blunt, Ordnance Department, recorder of the Board on Magazine Arms. It is not expected that any live cartridges caliber .30 will be ready for firing for some months to come, as the powder has to be received from Europe. When the powder has been received and a supply of cartridges manufactured, sufficient in the estimation of the board for making all the necessary official tests of all the arms submitted to it, a supply of cartridges can be manufactured for sale in limited quantities to inventors desiring to test their mechanisms before submission to the board. Please return these papers.

By order of the Chief of Ordnance.

D. A. HOWARD,
Lieut., Ord. Dept.

ORDNANCE OFFICE,
Washington, D. C., December 22, 1890.

Respectfully returned to Capt. S. E. Blunt, Ordnance Department, recorder of the Board on Magazine Arms. This Department is not prepared at this time to supply caliber .30 barrels to inventors.

By order of the Chief of Ordnance.

D. A. HOWARD,
Lieut., Ord. Dept., U. S. A.

The board directed the recorder to embody the substance of the preceding indorsements in any replies he might make to requests from inventors for cartridges or barrels. The board then adjourned until the 21st instant.

ARMY BUILDING,
New York City, January 21, 1891.

The board met pursuant to adjournment.

Present: All the members.

Mr. W. H. Elliott, of Brooklyn, N. Y., appeared before the board, and exhibited wooden models of magazine arms of his invention, which were carefully examined by the board. The models were then withdrawn. The board adjourned until the 22d instant.

ARMY BUILDING,
New York City, January 22, 1891.

The board met pursuant to adjournment.

Present: All the members.

A letter (L. R. 36) referred to the board by the Chief of Ordnance

from Winfield S. Ayers, of Zanesville, Ohio, asking if the breech action of the Springfield rifle was preferable to any other, and stating that he had conceived a method of converting it to a magazine arm, was read, and the following reply (Letter Book, p. 55) sent:

OFFICE BOARD ON MAGAZINE ARMS,
New York, January 22, 1891.

Respectfully returned to the Chief of Ordnance. The board is of the opinion that an experience of many years in the hands of troops has proved that the breech action of the Springfield rifle provides an efficient mechanism for a single loader. As to how a modified Springfield rifle converted into a magazine arm would compare with other magazine arms the board can not at this time form any definite opinion, as an extended trial of such a modified system would first be necessary.

S. E. BLUNT,
Capt., Ord. Dept., U. S. A., Recorder.

Letters from G. F. Mormot, Paris, France (L. R., 38), desiring sufficient time for preparing a rifle, and from J. C. Raymond, New Brunswick, N. J. (L. R. 39), asking for dimensions of cartridge to be used by the board, were read, and appropriate replies (Letter Book, pp. 56 and 57) sent thereto.

The board then adjourned to the 23d instant.

ARMY BUILDING,
New York City, January 23, 1891.

The board met pursuant to adjournment.

Present: All the members.

The following letter (L. R., 40) was received from the Chief of Ordnance:

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, D. C., January 21, 1891.

SIR: The commanding officer of National Armory has been instructed to turn over for the use of the board for examination and test samples of the Danish and English magazine rifles, with such ammunition therefor as is now on hand. The Department has ordered a further supply of ammunition for these two guns to enable the board to make a more extended test. I inclose herewith for the information of the board preliminary reports of trials made with these guns by Capt. S. E. Blunt, of the Ordnance Department. After examination of these papers, it is requested that they may be returned, as they pertain to the files of this office.

Respectfully,

S. V. BENÉT,
Brig. Gen., Chief of Ordnance.

The PRESIDENT OF THE MAGAZINE ARMS BOARD,
Army Building, New York City.

Pending receipt of the ammunition and the trial of the rifles above mentioned, this letter and the inclosed reports were, after an extended examination thereof, placed on file.

The board then adjourned to the 24th instant.

ARMY BUILDING,
New York City, January 24, 1891.

The board met pursuant to adjournment.

Present: All the members.

Mr. E. Page Davis, of New York City, appeared before the board and exhibited a magazine rifle of his invention. The rifle being how-

ever of .44 caliber, and adapted for a cartridge considerably shorter than the Frankford Arsenal experimental cartridge, was not formally submitted to the board. The following letter was written to the Chief of Ordnance, U. S. Army:

OFFICE OF THE BOARD ON MAGAZINE ARMS,
Army Building, New York City, January 24, 1891.

SIR: I have the honor to inform you that the Board on Magazine Guns will adjourn to-day, to meet at the National Armory on Monday, March 2, 1891.

At this session of the board several inventors have appeared and exhibited informally certain guns, but having none ready of the proper caliber, none were officially submitted.

It is proposed at the next meeting of the board to proceed with the regular tests of the English and Danish magazine guns, provided the ammunition, as mentioned in letter from your office of the 21st instant, is received in time.

Respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord. Dept., Recorder.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

The board then adjourned to meet at the National Armory, Springfield, Mass., on March 2, 1891.

NATIONAL ARMORY,
Springfield, Mass., March 2, 1891.

The board met pursuant to adjournment.

Present: Col. Kautz, Lieut. Col. Hall, Capts. Freeman and Blunt.

Absent: Maj. McKee, attending a meeting of the Board for Testing Rifled Cannon, in accordance with paragraph 17, Special Orders 44, Headquarters of the Army, of February 26, 1891, and Capt. Anderson, at the Yellowstone National Park, Wyoming, as superintendent thereof, in accordance with paragraph 17, Special Orders 17, Headquarters of the Army, of January 21, 1891.

The recorder laid before the board the correspondence conducted by him since the last adjournment. This included letters requesting copies of the rules for tests, sample cartridges or information with reference to rifling, the pressure anticipated with the Frankford Arsenal experimental cartridge, and various other matters from E. M. Patten, Yuma, Colo. (L. R., 41 and 63); E. F. Edgecomb, Mechanics Falls, Me. (L. R., 24); Henry Nixon, Thomasville, Ala. (L. R., 44); Albert Bierstadt, New York City (L. R., 45); Seighlin Conroy, New York City (L. R., 47); C. D. Kuback, Baltimore, Md. (L. R., 50); H. G. Catlin, New York City (L. R., 51); J. L. White, Pittsburg, Pa. (L. R., 53); J. C. Powell, Macon, Ga. (L. R., 57); James Duane, New York City (L. R., 58); R. M. Catlin, Tuscarora, Nev. (L. R. 60), and J. A. Fairbanks, Augusta, Me. (L. R. 62). Letters submitting drawings and descriptions of magazine guns from Sergt. C. J. Wahlquist, Twentieth United States Infantry, Fort Assinniboine, Mont. (L. R., 43), and from P. P. Fritz-Marti, Winter-thour, Switzerland (L. R., 59). Letters requesting caliber .30 cartridges from Capt. T. H. Logan, U. S. Army (L. R., 46), and from M. H. Durst, London, England (L. R., 48 and 49). Letter desiring to purchase caliber .30 barrel from Theodore McGarnish, New York City (L. R., 52). The replies of the recorder (Letter Book, pp. 59 to 90, inclusive) to these various communications were also submitted. The recorder also laid before the board an indorsement upon the application

of E. M. Patten to submit a gun of ordinary caliber, as he was unable to obtain a caliber .30 barrel, as follows:

OFFICE BOARD ON MAGAZINE ARMS.
National Armory, Springfield, Mass., February 13, 1891.

Respectfully returned to the Chief of Ordnance, U. S. Army. Under date of January 28, 1891, I sent Mr. Patten copies of the order convening the board, the rules for tests, and a dummy cartridge to show required size of receiver, etc. Under the order, discretion to accept a caliber other than .30 is not vested in the board, but in the Chief of Ordnance (to which fact Mr. Patten's attention was duly invited), and for sake of uniformity in the tests to which the guns are subjected it is not desirable that any arms submitted, except those adopted by foreign governments, should differ from this standard. The proposition to supply upon request caliber .30 barrel to inventors was by the board commended to the favorable consideration of the Chief of Ordnance by the first indorsement on O. O., file No. 7458 of 1890, and by letter of December 19, 1890, but the Chief of Ordnance under date of December 22, 1890, not approving the proposition, inventors, when asking about barrels, have since been informed of his decision.

S. E. BLUNT,
Capt., Ord. Dept., Recorder.

The following letters to the Chief of Ordnance were also laid before the board:

OFFICE OF THE BOARD ON MAGAZINE ARMS,
NATIONAL ARMORY,
Springfield, Mass., February 11, 1891.

SIR: By letters, from your office, of January 19 and 21, 1891, the Danish and the English magazine guns were turned over to the Board on Magazine Arms for examination and test. These guns are now in my possession, and, if their ammunition is received in time, will be tried at the next meeting of the board, March 2, 1891. A Mannlicher (Austrian) gun will soon reach this armory, and after its preliminary trial can, I presume, be laid before the board in a manner similar to the Danish and English; and a Japanese gun, it is understood, is also expected. While these four arms are all of systems approved abroad, yet there are others which it might be advisable to examine; of these the Schmidt (Swiss), the German infantry rifle of 1888, the Belgian gun of 1889, the Kropatschek (Portugal), and the Lebel (French) possess the most characteristic features, and I would, therefore, recommend, if it meets the approval of the Department, that steps be taken to obtain them and 1,200 rounds of ammunition for each for examination and test by the board.

Very respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord. Dept., Recorder.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

OFFICE OF THE BOARD ON MAGAZINE ARMS,
NATIONAL ARMORY,
Springfield, Mass., February 13, 1891.

SIR: I have the honor to request authority for the Board on Magazine Arms to employ from time to time, as may be required, the following assistants: One clerk at $100 per month, one draftsman at $3.50 a day, two mechanics at $3.50 each a day.

Authority is asked to employ two mechanics, as occasionally both will be needed, though most of the time the services of one will suffice.

Very respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord., Dept., Recorder.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

After consideration, all this correspondence was approved by the board. The recorder also submitted an indorsement (L. R., 64) of the Chief of Ordnance of February 20, 1891, approving the recommendation of Col. A. R. Buffington, Ordnance Department, commanding the National Armory, that a caliber .30 Springfield rifle (single-loader), which

was in process of manufacture under his direction, be tested by the board in comparison with magazine arms, and that the Rubin, Schulhof, and Krag-Jörgensen magazine guns now at the armory, and the Mannlicher, which was expected, be also turned over to the board for examination and test.

A letter (L. R., 65) from the Chief of Ordnance, stating that steps had been taken to procure the arms and ammunition mentioned in the recorder's letter of the 11th ultimo, was received and read. The board then proceeded to test the Lee-Speed (English) gun, completing the safety test and those for rapidity with accuracy and rapidity at will, with results as stated in the synopsis of tests (see No. 1). After partly completing the endurance test, the board, at 5 p. m., adjourned until 9:30 a. m. the 3d instant.

NATIONAL ARMORY,
Springfield, Mass., March 3, 1891.

The board met pursuant to adjournment.

Present: Col. Kautz, Lieut. Col. Hall, Capts. Freeman and Blunt.

Absent: Maj. McKee and Capt. Anderson.

A letter (L. R., 66) from M. H. Durst, London, England, desiring to purchase shells, primers, and bullets, was read and forwarded to the Chief of Ordnance (Letter Book, p. 91), recommending favorable consideration.

The test of the Lee-Speed gun was then continued, with results as stated in the synopsis. During prosecution of the test Maj. McKee arrived and resumed his duties as member of the board. The board then, at 5 p. m., adjourned to meet at 9:30 a. m. on the 4th instant.

NATIONAL ARMORY,
Springfield, Mass., March 4, 1891.

The board met pursuant to adjournment.

Present: Col. Kautz, Lieut. Col. Hall, Maj. McKee, and Capt. Blunt.

Absent: Capt. Freeman, in attendance upon a board for his examination for promotion, in accordance with paragraph 2, Special Orders 38, Headquarters of the Army, of February 16, 1891, and Capt. Anderson.

The board continued the test of the Lee-Speed gun, completing all the regular tests, with the results stated in the synopsis. The board then, at 4:30 p. m., adjourned to meet at 10 a. m. the following day.

NATIONAL ARMORY,
Springfield, Mass., March 5, 1891.

The board met pursuant to adjournment.

Present: Col. Kautz, Lieut. Col. Hall, Maj. McKee, and Capt. Blunt.

Absent: Capts. Freeman and Anderson.

The ammunition for the Danish magazine gun not having arrived, and no other guns having been received for test, the board, after consideration of the trial of the Lee-Speed arm, having no further business before it, adjourned to meet at the Army Building, New York City, on April 14, 1891.

ARMY BUILDING,
New York City, April 14, 1891.

The board met pursuant to adjournment.

Present: Col. Kautz, Lieut. Col. Hall, Maj. McKee, and Capt. Blunt

Absent: Capt. Freeman, on account of sickness, and Capt. Anderson.

The recorder laid before the board the correspondence conducted by him since the last adjournment. This included letters desiring information or sample cartridges from John R. Dos Passos, New York City (L. R., 78); Sneider Arms Company, Baltimore, Md. (L. R., 81), and H. A. Lewis, Philadelphia, Pa. (L. R., 89).

A letter submitting drawings and descriptions of rifles and revolvers from Andrew Brocadello, Padora, Italy (L. R., 72). A letter offering to sell right to make magazine for rifles from John M. Ross, Newcastle, England (L. R., 68). Letters desiring to purchase caliber .30 barrels from A. Burgess, New York City (L. R., 70 and 95), and the Lee Arms Company, South Windham, Conn. (L. R., 92). Letters desiring to purchase caliber .30 cartridges, or the component parts thereof, from John B. Mormot, New York City (L. R., 69 and 76); Capt. O. Krag, Kongsberg, Norway (L. R., 74 and 75); Lee Arms Company, South Windham, Conn. (L. R., 77 and 80); Winchester Arms Company, New Haven, Conn. (L. R., 79 and 82); M. H. Durst, London, England (L. R., 93), and H. A. Lewis, Philadelphia, Pa. (L. R., 94). A letter from Maj. Philip T. Godsal, Eton, England (L. R., 91), desiring to submit a breech mechanism of his invention. A letter from Maj. J. C. Post, United States Engineers, military attaché at London, England, desiring copy of official information resulting from test of the Lee-Speed gun (L. R., 88). A letter from Ensign H. H. Eames, U. S. Navy (L. R., 90), stating that Herr Mauser proposes to submit a Belgian Mauser, caliber .30, to the board. A letter forwarded by the Chief of Ordnance from Gen. J. C. Kelton, Adjutant-General U. S. Army, submitting his modification of the Springfield rifle with his attached magazine (L. R., 96). Letters from the Chief of Ordnance, transmitting reports of the United States minister to Switzerland (L. R., 83), with reference to procuring the Schmidt rifle; the United States military attaché at Berlin (L. R., 86), with reference to the German infantry rifle, and the United States military attaché at Vienna, with reference to the Mannlicher rifle (L. R., 86). A letter transmitting drawings and description of the Bergman magazine gun (L. R., 73), and also the following letters (L. R., 66 and 87):

ORDNANCE OFFICE,
Washington, March 7, 1891.

Respectfully returned to the Board on Magazine Arms, with the information that the commanding officer of Frankford Arsenal has this day been authorized to sell such limited number of components of the caliber .30 cartridges to such inventors as may be designated by the recorder of the Board on Magazine Arms.

By order of the Chief of Ordnance.

D. A. HOWARD,
Lieut., Ord. Dept., U. S. A.

ORDNANCE OFFICE,
Washington, March 26, 1891.

SIR: I have to inform you that the commanding officer of the National Armory has this day been instructed to manufacture and sell to such inventors as you may indicate caliber .30 barrels for magazine arms at cost price, probably about $15 each.

Respectfully,

CHAS. S. SMITH,
Capt., Ord. Dept. U. S. A., Acting Chief of Ordnance.

Capt. S. E. BLUNT,
Recorder Board on Magazine Arms,
National Armory, Springfield, Mass.

The replies of the recorder to these various communications, including letters to all inventors who had requested caliber .30 barrels or cartridges, informing them that the Ordnance Department was now prepared to supply such articles (Letter Book, pp. 92 to 167, inclusive), were also submitted and after consideration approved by the board. The board then proceeded to consider the request of the United States military attaché at London, England, for information as to the results of the test of the Lee-Speed gun, and directed that a copy of the synopsis of tests of the arm be furnished the Adjutant-General of the Army, with recommendation that, if deemed advisable, it be transmitted to Maj. Post.

The board then adjourned to the 15th instant.

ARMY BUILDING,
New York City, April 15, 1891.

The board met pursuant to adjournment.

Present: Col. Kautz, Lieut. Col. Hall, Maj. McKee, and Capt. Blunt.

Absent: Capts. Freeman and Anderson.

Several persons appeared before the board with inquiries as to its proposed methods of procedure and the probable date when actual tests would be commenced.

After discussion of these matter the board adjourned until the 16th instant.

ARMY BUILDING,
New York City, April 16, 1891.

The board met pursuant to adjournment.

Present: Col. Kautz, Lieut. Col. Hall, Maj. McKee, and Capt. Blunt.

Absent: Capts. Freeman and Anderson.

Mr. Frank Rees, of No. 17 Ferry street, New York City, and Mr. O. S. Teall, of New York City, appeared before the board with a magazine gun invented by the former and explained its mechanism, but the arm, being of a .44 caliber and otherwise not adapted to the Frankford Arsenal cartridge, was not formally submitted.

The board then adjourned to the 17th instant.

ARMY BUILDING,
New York City, April 17, 1891.

The board met pursuant to adjournment.

Present: Col. Kautz, Lieut. Col. Hall, Maj. McKee, and Capt. Blunt.

Absent: Capts. Freeman and Anderson.

The recorder stated that on the last of March the Wetteren powder intended for the cartridges to be used by the board in tests of arms submitted had finally reached New York from Europe, and on the 11th instant the trials to determine the proper charge had been completed at the National Armory, and the results communicated to the Chief of Ordnance and to Maj. Geo. W. McKee, commanding Frankford Arsenal.

Maj. McKee stated that the powder had been received at Frankford and that the manufacture of the cartridges was under way with prospect of a sufficient amount being completed early in May for the immediate needs of the board. The recorder was therefore directed to inform such inventors as had indicated their intention of submitting

magazine guns that on and after May 12 the board would be prepared to receive their guns and subject them to examination and test. There being no further business before the board it then adjourned, to meet at the National Armory, Springfield, Mass., May 12, 1891.

NATIONAL ARMORY,
Springfield, Mass., May 12, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. McKee, Capts. Freeman and Blunt.

Absent: Brig. Gen. Kautz, as member of court of inquiry at Fort Walla Walla, State of Washington, pursuant to paragraph 1, Special Orders 105, Headquarters of the Army, of May 8, 1891, and Capt. Anderson, at the Yellowstone National Park, Wyoming, as superintendent thereof, in accordance with paragraph 17, Special Orders 17, Headquarters of the Army, January 21, 1891. Brig. Gen. Kautz, having been promoted to that grade from colonel Eighth Infantry, is entered on the minutes as of the higher rank.

The recorder laid before the board the correspondence conducted by him since the last adjournment. This included letters requesting sample cartridges, or information on various points, from W. H. Jaques, South Bethlehem, Pa. (L. R., 100 and 111); F. A. Busse, Hartford, Conn. (L. R., 102); H. H. Cummings & Co., Boston, Mass. (L. R., 108 to 112 and 117), and J. C. Raymond, New Brunswick, N. J. (L. R., 133). A letter from Randall Bisbee, New York, desiring to show his improved cartridge (L. R., 109). A letter from E. B. Marsh, Amherst, Mass., requesting permission to examine the magazine guns before the board (L. R., 113). Letters from E. M. Patten, Yuma, Colo., with reference to his plans of magazine gun (L. R., 101, 110, and 124). Letters from J. W. Roberts, Springfield, Mass. (L. R., 115), and W. S. Hinman, Springfield, Mass. (L. R., 121), applying for position as clerk to the board. A letter from E. Beckstein, Hartford, Conn. (L. R., 119), submitting the Mauser magazine gun, model 1890. A letter from Maj. P. T. Godsal, Windsor, England, with reference to the magazine gun he proposed to submit (L. R., 130). Letters from the Winchester Repeating Arms Company (L. R., 131) and the Lee Arms Company (L. R., 132), with reference to caliber .30 cartridges. Letters from the commanding officer Frankford Arsenal, with reference to the sale and price of caliber .30 cartridges (L. R., 126 and 135). Letters from M. H. Durst, London, England, stating he would present his gun by July 1 (L. R., 105 and 127). A letter from the Adjutant-General of the Army, directing the board or its recorder to make, at least once a month, to the Chief of Ordnance reports of the work of the board, the tests in progress, and those contemplated (L. R., 120), and letters from the Chief of Ordnance on the following subjects: Authorizing draughtsman and mechanic for the board (L. R., 99), authorizing sale of caliber .30 cartridges (L. R., 122), with reference to the Livermore-Russell caliber .45 magazine gun (L. R., 107), inclosing reports of the United States ministers or military attachés abroad stating that the following guns had been procured for the board: the Belgian magazine gun, model 1889 (L. R., 103); the Japanese magazine gun (L. R., 104); the Portuguese magazine gun (L. R., 114); the German magazine gun (L. R., 129), and the Mannlicher (Austrian) gun and cartridges (L. R., 116 and 128), and Nobel smokeless powder for the same (L. R., 118).

The replies of the recorder to these various communications were

also submitted and approved by the board. These included a report (Letter Book, p. 197) rendered on May 6, 1891, to the Chief of Ordnance of the transactions of the board covering the period from the date of the order convening the board, and also the following letter sent to the Lee Arms Company and to all other firms or individuals who had manifested a disposition to prepare guns for test by the board.

OFFICE OF THE BOARD ON MAGAZINE ARMS,
NATIONAL ARMORY,
Springfield, Mass., May 6, 1891.

DEAR SIR: I have to inform you that the smokeless powder for the cartridges to be used by the Board on Magazine Arms in the test of guns submitted for its examination having been received, the board, after the 12th instant, will be ready to proceed with the trials whenever guns may be presented. Please advise me when you expect to submit your gun. If, however, it is not yet completed, you will be afforded ample opportunity for further work upon it, as the sessions of the board will probably continue for some time to come.

Respectfully,

S. E. BLUNT,
Capt., Ord. Dept., U. S. A., Recorder.

The LEE ARMS COMPANY,
South Windham, Conn.

The board then proceeded to test the Krag-Jörgensen (Danish) gun, completing the safety test and those for rapidity with accuracy and rapidity at will with results as stated in the synopsis of tests (see No. 2). After partly completing the endurance test, the board, at 4:40 p. m., adjourned until 10 a. m. the 13th instant.

NATIONAL ARMORY,
Springfield, Mass., May 13, 1891.

The board met pursuant to adjournment.
Present: Lieut. Col. Hall, Maj. McKee, Capts. Freeman and Blunt.
Absent: Brig. Gen. Kautz and Capt. Anderson.

Letters (L. R. 136) from J. H. Acton, Aurora, Ill., with reference to obtaining caliber .30 barrel and cartridges, and from W. H. Jaques, South Bethlehem, Pa. (L. R. 137), stating he hoped to have gun to present to the board, were received and appropriate replies sent (Letter Book, p. 224). The board then proceeded to test the Mannlicher (Austrian) gun, completing the safety test and that for rapidity with accuracy and partially conducted the tests for rapidity at will and for endurance, with results as stated in the synopsis of tests (see No. 3). The Austrian ammunition provided with the arm not proving satisfactory, further tests of the gun were discontinued until an additional supply could be obtained. The board then, at 4 p. m. adjourned until the 14th instant.

NATIONAL ARMORY,
Springfield, Mass., May 14, 1891.

The board met pursuant to adjournment.
Present: Lieut. Col. Hall, Maj. McKee, Capts. Freeman and Blunt.
Absent: Brig. Gen. Kautz and Capt. Anderson.

A letter (L. R., 138) was received from J. V. Meigs, Boston, Mass., stating that his gun was not and could not well be adapted to the new

caliber .30 cartridge, to which an appropriate reply (Letter Book, p. 227) was sent.

A letter (L. R., 139) from Recknagel & Co., New York, was received, asking if the rifle they wished to submit must be of .30 caliber, which inquiry was answered as follows:

OFFICE OF THE BOARD ON MAGAZINE ARMS,
NATIONAL ARMORY,
Springfield, Mass., May 14, 1891.

GENTLEMEN: In reply to your letter of the 13th instant I inclose a copy of the order convening the board, and also of the rules adopted to govern tests of arms submitted. From these you will see that the War Department has decided upon, and required us to observe, as well as the inventors, the conditions that the guns should be of a .30 caliber and should be adapted to the new cartridge of that size, of which I inclose a sample (dummy).

There would be nothing gained by submitting to the board any gun not conforming to these requirements, as we could not test it, nor give it in our ultimate report the consideration which its other merits might deserve.

If you should decide to so modify your gun that it will shoot these new cartridges, the Ordnance Department will sell you at cost price a caliber .30 barrel (price $15), and smokeless powder caliber .30 cartridges (price $3 per hundred), for any preliminary tests you may desire to make.

The board will probably be in session from time to time for some months to come.

Respectfully,

S. E. BLUNT,
Capt., Ord. Dept., U. S. A., Recorder.

RECKNAGEL & CO.,
136 Liberty Street, New York City.

The trial of the Krag-Jörgensen gun was then resumed, completing the remainder of the regular tests and the first of the supplementary tests, with results as stated in the synopsis of tests (No. 2). At 4:30 p. m. the board adjourned to meet on the following day.

NATIONAL ARMORY,
Springfield, Mass., May 15, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. McKee, Capts. Freeman and Blunt.

Absent: Brig. Gen. Kautz and Capt. Anderson.

Letters were received from John R. Dos Passos, New York (L. R., 140), Winchester Repeating Arms Company, New Haven, Conn. (L. R., 141), and Edward B. Marsh, Amherst, Mass. (L. R., 142), with reference to magazine arms, and drawings of the same, and caliber .30 cartridges. The board then proceeded to the trial of the Springfield single loader, caliber .30, the rules for tests being observed as far as they were applicable to a single loader. The regular tests and the first of the supplementary tests were completed, with results as stated in the synopsis of tests (see No. 51). The board, then, at 5 p. m., adjourned to the following day.

NATIONAL ARMORY,
Springfield, Mass., May 16, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. McKee, Capts. Freeman and Blunt.

Absent: Brig. Gen. Kautz and Capt. Anderson.

A letter (L. R., 143) was received from the Lee Arms Company with reference to the gun they proposed to submit, and reply sent (Letter Book, p. 231).

The board proceeded with the second supplementary test (the rust test) of the Krag-Jörgensen and Springfield guns, subjecting them to the preliminary stage, and then commenced the trial of the Sporer magazine arm, subjecting it to the safety test and to a portion of the first regular test, with results as stated in the synopsis. The gun was then withdrawn for modification, and the board adjourned to meet on Monday, the 18th instant, at 9 a. m.

NATIONAL ARMORY,
Springfield, Mass., May 18, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. McKee, Capts. Freeman and Blunt.

Absent: Brig. Gen. Kautz and Capt. Anderson.

A letter was received from J. H. Acton, Aurora, Ill. (L. R., 144), making inquiries as to the caliber .30 barrels to be sold inventors, which was duly answered (Letter Book, p. 233). The rust test of the Krag-Jörgensen and Springfield guns was completed, with results as in the synopsis. There being no other guns before the board awaiting test, and no immediate prospect of any being submitted, the board then adjourned to meet at the Army Building, New York City, on Tuesday, June 9, 1891.

ARMY BUILDING,
New York City, June 9, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. McKee, Capts. Freeman and Blunt.

Absent: Brig. Gen. Kautz, as member of court of inquiry at Fort Walla Walla, State of Washington, pursuant to paragraph 1, Special Orders 105, Headquarters of the Army, of May 8, 1891, and Capt. Anderson, at the Yellowstone National Park, Wyoming, as superintendent thereof, in accordance with paragraph 17, Special Orders 17, Headquarters of the Army, January 21, 1891.

The recorder laid before the board the correspondence conducted by him since the last adjournment. This included letters requesting sample cartridges, information on various points, etc., from W. S. Ayres, Zanesville, Ohio (L. R., 151); Henry Guinard, New York City (L. R., 155); R. M. Catlin, Tuscarora, Nev. (L. R., 162); Riley Bowers, Springfield, Ill. (L. R., 165); Phillip, Munson, Phelps & Hovey, New York City (L. R., 168), and M. L. S. Buckner, Shelbyville, Ky. (L. R., 171).

Letters from W. H. Elliott, Brooklyn, N. Y. (L. R., 146); J. C. Sturgeon, Erie, Pa. (L. R., 150), and T. F. Cooke, Algona, Iowa (L. R., 157), stating they would not be able, as they had at first proposed, to submit guns to the board. A letter from S. Conroy, New York City (L. R., 158), with reference to his desire to submit drawings. A letter from J. V. Meigs, Boston, Mass. (L. R., 166), with reference to gun of his invention of a greater caliber than .30. A letter from Dr. Edmund Andrews, Chicago, Ill. (L. R., 170), desiring to borrow a small caliber rifle for certain experiments. A letter from the Sneider Arms Company, Baltimore, Md. (L. R., 156), desiring to purchase smokeless powder. Letters desiring to purchase caliber .30 barrels from the Winchester Arms Company, New Haven, Conn. (L. R., 148 and 163); H. A. Lewis, Philadelphia, Pa. (L. R., 153); J. H. Acton, Aurora, Ill. (L. R., 154), and

the U. S. military attaché at Vienna for Mr. Mannlicher (L. R., 161). Desiring to purchase caliber .30 barrels and cartridges for the same, from the Pitcher Automatic Repeating Arms Company, Neillsville, Wis. (L. R., 164), and Simon Stevens, New York City (L. R., 167); and letters from the Chief of Ordnance forwarding reports of the U. S. military attachés at Berlin (L. R., 159) and Vienna (L. R., 161), with reference to shipments to the board of the German and Mannlicher magazine rifles and their ammunition.

The replies of the recorder to these various communications (Letter Book, pp. 236 to 280, inclusive) were also submitted and approved by the board.

These included also a report under date of May 19, 1891, to the Chief of Ordnance of the transactions of the board since the former report of May 6.

The board then adjourned until the 10th instant.

ARMY BUILDING,
New York City, June 10, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Capts. Freeman and Blunt.

Absent: Brig. Gen. Kautz, by virtue of Special Orders 105, Headquarters of the Army, of May 8, 1891; Maj. McKee, by permission of the board, and Capt. Anderson, by virtue of Special Orders 17, Headquarters of the Army, of January 21, 1891.

A letter (L. R., 172) was received from M. H. Durst, of London, England, acknowledging receipt of caliber .30 cartridges and stating that he would soon have gun ready to submit; and a letter (L. R., 173) from Riley Bowers, Springfield, Ill., making inquiries as to the pressure induced by Wetteren powder.

The following letter was addressed to the Chief of Ordnance:

OFFICE OF THE BOARD ON MAGAZINE ARMS,
Army Building, New York City, June 10, 1891.

SIR: The Board on Magazine Arms deems it for the best interest of the service and of inventors to conduct some of the trials of guns at New York, and as the facilities at the Army Building are not adequate for the purpose, I am directed by the board to request that authority be granted for the prosecution of tests at the New York Arsenal and at Fort Columbus, Governors Island, and that the commanding officers thereof be desired to extend to the board such facilities as may be at their command.

Very respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord. Dept., U. S. A., Recorder.

CHIEF OF ORDNANCE, U. S. ARMY.

The board then adjourned until the 11th instant.

ARMY BUILDING,
New York City, June 11, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Capts. Freeman and Blunt.

Absent: Brig. Gen. Kautz, by virtue of Special Orders 105, Headquarters of the Army, of May 8, 1891; Maj. McKee, by permission of the board, and Capt. Anderson, by virtue of Special Orders 17, Headquarters of the Army, of January 21, 1891.

The following letter was addressed to the Chief of Ordnance:

OFFICE OF THE BOARD ON MAGAZINE ARMS,
Army Building, New York City, June 11, 1891.

SIR: I have the honor, by direction of the board, to inclose herewith the synopsis of the tests to which the Krag-Jörgensen magazine gun, caliber .315, was lately subjected.

These trials developed one or two minor points in which the gun failed to fully come up to the requirements, and this synopsis is now forwarded, with the view of enabling the Department, if it deems it advisable, to inform the inventor, Capt. Krag, so that he may endeavor to eradicate the cause of trouble in the gun of our standard (0.30) caliber, which he has advised the board he proposes to submit. Under the regulations adopted by the board (copy inclosed) inventors are entitled to witness the tests of their guns, and, of course, to take note of any defects developed. Capt. Krag, whose address is Royal Manufactory of Arms, Kongsberg, Norway, had no representative at the late trials, and was therefore unable to avail himself of the privilege he could otherwise have enjoyed.

Very respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord. Dept., U. S. A., Recorder.

The CHIEF OF ORDNANCE,
Washington, D. C.

The board then adjourned until the 15th instant.

ARMY BUILDING,
New York City, June 15, 1891.

The board met pursuant to adjournment.

Present: Capts. Freeman and Blunt.

Absent: Brig. Gen. Kautz, by virtue of Special Orders 105, Headquarters of the Army, of May 8, 1891; Lieut. Col. Hall and Maj. McKee, by permission of the board, and Capt. Anderson, by virtue of Special Orders 17, Headquarters of the Army, of January 21, 1891.

Letters were received from E. M. Patten, Yuma, Colo. (L. R., 174), with reference to drawings he had submitted, and from the Chief of Ordnance (L. R., 175), stating that the dummy cartridges desired by the board had been ordered issued, and (L. R., 176) in reply to and approving of the board's request of the 10th instant. A reply (Letter Book, p. 285) was sent to the letter of Mr. Riley Bowers, received on the 10th instant.

The board then adjourned to meet at the Army Building, New York City, on Tuesday, June 23, 1891.

ARMY BUILDING,
New York City, June 23, 1891.

The board met pursuant to adjournment.

Present: Brig. Gen. Kautz, Lieut. Col. Hall, Maj. Freeman, and Capt. Blunt.

Absent: Maj. McKee, on leave of absence under authority of Ordnance Orders No. 13 of June, 1891, and Capt. Anderson, at the Yellowstone National Park, by virtue of Special Orders 17, Headquarters of the Army, of January 21, 1891.

Maj. Freeman, promoted from captain, Seventh Infantry, and assigned to the Sixteenth Infantry, took his seat as of that rank.

The recorder laid before the board the correspondence conducted by him since the last adjournment. This included a letter (L. R., 177) from

Mr. Simon Stevens, New York, with reference to the caliber .30 barrel he desired to purchase, and one from Col. Mordecai, Ordnance Department, commanding New York Arsenal (L. R., 178), with reference to facilities for tests of arms at Governors Island.

Replies to these communications and letters to the commanding officers National Armory, Fort Columbus, and New York Arsenal (Letter Book, pp. 287 to 295, inclusive), with reference to these trials, were also submitted. After examination, all this correspondence was approved by the board.

Upon inquiry of Maj. W. L. Haskin, First Artillery, commanding Fort Columbus, it was learned that he had not yet received authority to grant permission for the tests at Fort Columbus, according to request which had been laid before the Secretary of War by the Chief of Ordnance after the board's recommendation of the 10th instant.

A telegram (Letter Book, p. 296) was therefore addressed to the Chief of Ordnance on the subject.

The board then adjourned until the 24th instant.

ARMY BUILDING,
New York City, June 24, 1891.

The board met pursuant to adjournment.

Present: Brig. Gen. Kautz, Lieut. Col. Hall, Maj. Freeman, and Capt. Blunt.

Absent: Maj. McKee and Capt. Anderson.

Telegrams (L. R., 179 and 180) of June 23 and June 24 from the Chief of Ordnance, stating the Adjutant-General of the Army had telegraphed to the commanding general Division of the Atlantic the authority desired for trials at Fort Columbus, were received and subsequently exhibited to the commanding officer Fort Columbus.

The board then adjourned to the 25th instant.

ARMY BUILDING,
New York City, June 25, 1891.

The board met pursuant to adjournment.

Present: Brig. Gen. Kautz, Lieut. Col. Hall, Maj. Freeman, and Capt. Blunt.

Absent: Maj. McKee and Capt. Anderson.

The recorder reported to the board that he had examined the ditch at Fort Columbus with the commanding officer New York Arsenal, and had selected a place where, after a suitable butt should be erected, the tests of the board could be conducted without any possibility of danger or any annoyance to the occupants of the fort; that this location had been assented to by the commanding officer Fort Columbus; that Col. Mordecai had immediately commenced the erection of the wooden portion of the butt, and that Maj. Haskin had agreed to have it filled with sand, of which about 30 cubic yards would be required.

A letter was received from Riley Bowers, Springfield, Ill. (L. R., 182), and an appropriate reply (Letter Book, p. 297) was sent.

The board then adjourned to June 27.

ARMY BUILDING,
New York City, June 27, 1891.

The board met pursuant to adjournment.

Present: Brig. Gen. Kautz, Lieut. Col. Hall, Maj. Freeman, and Capt. Blunt.

Absent: Maj. McKee and Capt. Anderson.

The recorder reported to the board that he had examined on the 26th, and also on that morning, the work on the butt at Fort Columbus and that it was not yet ready for firing. A letter (L. R., 183) was received from M. L. S. Buckner, Shelbyville, Ky., desiring additional dummy cartridges, and asking various questions, to which reply (Letter Book, p. 298) was sent.

The board then adjourned until Monday, the 29th instant.

ARMY BUILDING,
New York City, June 29, 1891.

The board met pursuant to adjournment.

Present: Brig. Gen. Kautz, Lieut. Col. Hall, Maj. Freeman, and Capt. Blunt.

Absent: Maj. McKee and Capt. Anderson.

A letter (L. R., 184) was received from the Chief of Ordnance, inclosing copy of the instructions sent from the War Department to the commanding general Division of the Atlantic with reference to tests at Fort Columbus.

The board then proceeded to Governors Island and examined the progress of the work on the butt at Fort Columbus, when it being evident at the rate at which sand was being hauled it would require possibly a fortnight or possibly longer to so far fill the butt as to make it ready for firing, the board deemed it useless to remain longer then in session, and accordingly adjourned to meet at the Army Building, New York City, on Tuesday, July 28, 1891.

ARMY BUILDING,
New York City, July 28, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson, in accordance with paragraph 17, Special Orders 17, Headquarters of the Army, of January 21, 1891.

Brig. Gen. Kautz was also absent, having been relieved from the board by virtue of the following order:

SPECIAL ORDERS, No. 153.

HEADQUARTERS OF THE ARMY,
ADJUTANT-GENERAL'S OFFICE,
Washington, July 6, 1891.

[Extract.]

* * * * * * *

6. Brig. Gen. August V. Kautz, having been assigned to the command of the Department of the Columbia, headquarters Vancouver Barracks, Washington, is, by direction of the Acting Secretary of War, hereby relieved from the board to consider and recommend a magazine system for rifles and carbines, upon which he was detailed by General Orders No. 136, of 1890, from this office.

* * * * * * *

By command of Maj. Gen. Schofield.

J. C. KELTON,
Adjutant-General.

Official:
J. C. GILMORE,
Assistant Adjutant-General.

The recorder laid before the board the correspondence conducted by him since the last adjournment. This included a letter (L. R., 185) from the Winchester Arms Company, New Haven, Conn., desiring to purchase a caliber .30 barrel; a cablegram (L. R., 186) from Capt. O. Krag, Kongsberg, Norway, inquiring as to the length of the caliber .30 cartridge; letters (L. R., 190) from the Lee Arms Company, South Windham, Conn., stating they would have two guns ready for trial at an early day; from the United States Patent Promotion Company, Philadelphia, Pa. (L. R., 195), with reference to the magazine gun invented by C. J. Wahlquist; from Capt. O. Krag, Kongsberg, Norway (L. R., 194), stating he would have his gun ready in a few weeks, and would send Mr. Jörgensen from Norway to represent him; from E. M. Patten, Yuma, Colo. (L. R., 199), asking if he would have time after October 1 to present his gun for trial. Letters from the Chief of Ordnance, U. S. Army, furnishing copy of letter sent to J. V. Meigs, Boston, Mass. (L. R., 188), with reference to his magazine gun; report from the United States military attaché at St. Petersburg, with reference to the new Russian rifle (L. R. 191); letter (L. R., 192) from J. W. Powell, Tuscarora, Nev., with reference to the magazine gun of R. M. Catlin; the reports (L. R., 193 and 200) from the United States military attaché at Berlin, with reference to procuring the German magazine gun; copy (L. R., 196) of letter to Capt. O. Krag, transmitting synopsis of the board's test of the magazine gun caliber .315, as adopted by the Danish army, and a letter (L. R., 197) from Capt. A. H. Merrill, commanding Fort Columbus, stating that everything was ready and at the disposal of the board for their coming meeting.

The replies (Letter Book, pp. 301 to 329, inclusive) to these various communications were also laid before the board, including also a report of June 30, 1891, of the transactions of the board to that date and the following letter to the Chief of Ordnance:

OFFICE OF THE BOARD ON MAGAZINE ARMS,
NATIONAL ARMORY,
Springfield, Mass., July 6, 1891.

SIR: It is believed that last April the Russian Government, and lately the Italian Government, adopted magazine small arms for their armies.

Many of the new foreign small arms are already before the board, but it is possible that an examination of these two later ones might also be of benefit.

I have therefore the honor to recommend that the necessary steps be taken to procure them and 1,200 rounds of ammunition for each, or, if it is not practicable to secure the complete cartridges, to obtain 1,200 primed shells and bullets for each. The cartridges can then be loaded in this country with the smokeless powder to be used by the board in its trials of other guns.

Very respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord. Dept., U. S. A., Recorder.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

After examination, all this correspondence was approved by the board.

The board then adjourned to meet at Governors Island on the 29th instant.

GOVERNORS ISLAND,
New York Harbor, July 29, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

The board then proceeded to test the magazine gun presented by L. F. Bruce, of Springfield, Mass., completing the safety test and the regular tests to include the first part of the endurance test, with results as stated in the synopsis of tests, and adjourned, at 4:30 p. m., to meet at Governors Island on the 30th instant.

GOVERNORS ISLAND,
New York Harbor, July 30, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

A letter (Letter Book, p. 330) was addressed to the Lee Arms Company, stating the board would be ready to test their guns any day next week. The board then resumed the test of the Bruce gun, completing the endurance and dust tests, with results as stated in the synopsis. At the first test with defective cartridges the extractor was broken, and the gun then temporarily withdrawn that the extractor might be replaced.

Tests were then commenced with the Mauser magazine gun, caliber .301, adopted for the Belgian army, the safety test being completed and the regular tests to include that for rapidity with accuracy, with results as in the synopsis.

The board then adjourned to meet at Governors Island on the 31st.

GOVERNORS ISLAND,
New York Harbor, July 31, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

A letter (L. R., 201) was received from the Chief of Ordnance, furnishing the board copies of correspondence with reference to the Murata (Japanese) magazine rifle which had been received from Japan and forwarded to the board.

A letter (L. R., 202) was also received from Charles Nillin, Paris, France, desiring to submit his gun (a single loader) to the board, to which reply (Letter Book, p. 333) was sent. The test of the Bruce gun, the broken extractor having been replaced, was then resumed, the first of the defective cartridges being fired, with result as stated in the synopsis. The Bruce gun was then laid aside and trial resumed of the Belgian Mauser, the tests for rapidity at will, and endurance being completed, and also the preliminary part of the dust test, with results as in the synopsis of tests.

The board then adjourned to meet at Governors Island on Monday, August 3.

GOVERNORS ISLAND,
New York Harbor, August 3, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

A letter (L. R., 205) was received from Prof. W. Hebler, Zurich, Switzerland, with reference to the Kuska magazine rifle, to which a reply (Letter Book, p. 335) was sent. The test of the German infantry rifle, model 1888, was then commenced and continued, to include the endurance tests, with results as in the synopsis.

The board then adjourned to meet at Governors Island August 4, 1891.

GOVERNORS ISLAND,
New York Harbor, August 4, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

The test of the Belgian Mauser was then resumed, the dust test and the tests with defective cartridges being concluded, with results as in the synopsis. The trial of the German infantry rifle was continued as far as to include the dust test, with results as in the synopsis of tests.

The board then adjourned to meet at Governors Island August 5.

GOVERNORS ISLAND,
New York Harbor, August 5, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

The test of the German infantry rifle was resumed, the defective-cartridge test being concluded, with results as in the synopsis. The test of the Kropatschek (Portugal) magazine arm was commenced and continued through a portion of the endurance test, with results as in the synopsis of tests.

The board then adjourned to meet at Governors Island August 6.

GOVERNORS ISLAND,
New York Harbor, August 6, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

A letter (L. R., 206) was received from the Lee Arms Company with reference to the guns they proposed to present to the board, and a reply (Letter Book, p. 337) was sent. The test of the Kropatschek magazine arm was then resumed, commencing with the dust test, and with results as in the synopsis.

The test was then temporarily suspended, and the board adjourned to meet at Governors Island August 7.

GOVERNORS ISLAND,
New York Harbor, August 7, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

The test of the Kropatschek magazine arm was resumed, the dust and defective-cartridge tests being completed, with results as in the synopsis. Upon his application permission was accorded Mr. L. F. Bruce to withdraw his gun for repairs and alterations, and a letter so notifying him (Letter Book, p. 338) was sent.

The board then adjourned to meet on Monday, August 10, 1891.

ARMY BUILDING,
New York City, August 10, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

Letters were received from the Lee Arms Company (L. R., 207) reporting they would not have their guns ready to submit to the board for four or five weeks; from Maj. W. H. Rexford, National Armory (L. R., 208), advising the board of the receipt of certain boxes of arms and ammunition, and from Capt. O. Krag, Kongsberg, Norway (L. R., 209), with reference to the caliber .30 arm of his invention he proposed to submit to the board.

Replies were addressed to Maj. Rexford (Letter Book, p. 341) and to Capt. Krag (Letter Book, p. 342).

The board then adjourned until the 11th instant.

ARMY BUILDING,
New York City, August 11, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. Freeman, and Capt. Blunt.

Absent: Maj. McKee, on account of sickness, and Capt. Anderson.

There being no guns ready for trial, the board adjourned to the 13th instant.

ARMY BUILDING,
New York City, August 13, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. Freeman, and Capt. Blunt.

Absent: Maj. McKee and Capt. Anderson.

A letter (Letter Book, p. 344) was addressed to Col. Mordecai, commanding New York Arsenal, with reference to the shipment to the National Armory of the guns lately tested by the board.

The board then adjourned to the 15th instant.

ARMY BUILDING,
New York City, August 15, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. Freeman, and Capt. Blunt.

Absent: Maj. McKee and Capt. Anderson.

There being no guns on hand ready for trial, and no immediate prospect of any being received, the board adjourned to meet at the Army Building, New York City, on Tuesday, September 15, 1891.

ARMY BUILDING,
New York City, September 15, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson, at the Yellowstone National Park, Wyoming, as superintendent thereof, in accordance with paragraph 17, Special Orders 17, Headquarters of the Army, January 21, 1891.

The recorder laid before the board the correspondence conducted by him since the last adjournment. This included a report (Letter Book, p. 345) to the Chief of Ordnance of the transactions of the board since June 30, and the following letter (Letter Book, p. 353) sent to the Hotchkiss Ordnance Company and to all inventors who, from correspondence on file, it was believed were preparing guns for trial.

OFFICE OF THE BOARD ON MAGAZINE ARMS,
NATIONAL ARMORY,
Springfield, Mass., August 19, 1891.

GENTLEMEN: The Board on Magazine Arms will hold its next session at the Army Building, New York City, on September 15, 1891, and from that date will prosecute tests of arms submitted at Governors Island, New York Harbor.

Will you please inform me whether you expect to have a gun ready for this coming session of the board. Information on that point is now desired in order that arrangements convenient for all inventors may be made before the session commences.

Respectfully,

S. E. BLUNT,
Capt., Ord. Dept., U. S. A., Recorder.

HOTCHKISS ORDNANCE COMPANY,
1503 Pennsylvania avenue, Washington, D. C.

The following letters were also laid before the board:

Requests to purchase caliber .30 barrels from E. B. Riddle, Allegheny City, Pa. (L. R., 225), and from John Ford, Portneuf Station, Province of Quebec, Canada (L. R., 245); to purchase caliber .30 cartridges (L. R., 248) and parts of rifles (L. R., 211) from the Pitcher Automatic Repeating Firearms Company, Neillsville, Wis.

Replies to recorder's inquiry when their guns would be ready for test, fixing dates from six weeks to six months in the future, were received from Capt. O. Krag, Kongsberg, Norway (L. R., 213); Winchester Arms Company, New Haven, Conn. (L. R., 215); B. F. Dos Passos, New York (L. R., 216); United States Patent Promotion Company, Philadelphia, Pa. (L. R., 217); Hotchkiss Ordnance Company, Washington, D. C. (L. R., 218); Lee Arms Company, South Windham, Conn. (L. R., 220); H. H. Cummings & Co., Boston, Mass. (L. R., 221); Pitcher Automatic Repeating Firearms Company, Neillsville, Wis. (L. R., 222); M. H. Durst, London, England (L. R., 223); W. E. Blackburn, Anthony, Kans. (L. R., 226); Sneider Arms Company, Baltimore, Md.

(L. R., 229); A. Mauser, Hartford, Conn. (L. R., 230); W. H. Jaques, South Bethlehem, Pa. (L. R., 239); M. L. S. Buckner, Shelbyville, Ky. (L. R., 241), and J. H. Acton, Aurora, Ill. (L. R., 244).

A letter (L. R., 214) with reference to foreign arms from Col. A. Mordecai, commanding New York Arsenal, and from the Chief of Ordnance (L. R., 219) with reference to the board's request for ammunition for the Swiss rifle then on hand. A letter from Maj. Livermore, United States Engineers, and Capt. Russell, Ordnance Department (L. R., 246), and a letter from Maj. W L. Haskin, First Artillery, commanding Fort Columbus (L. R., 249), stating that the testing ground at his post was ready for the board's use.

Inquiries were also received as to the price of caliber .30 barrels and cartridges, the date when the board would probably submit its report, the requirements of magazine arms and various kindred subjects from G. T. Schley, Waverly, Md. (L. R., 212); A. Mercer, Norfolk, Va. (L. R., 224); J. W. Blake, Dalton, Ga. (L. R., 227); John Ford, Portneuf Station, Province of Quebec, Canada (L. R., 231); Lewis Altmaier, Philadelphia, Pa. (L. R., 232 and 237); D. C. Green, Bellefontaine, Ohio (L. R., 233); A. W. Roovers, Brooklyn, N. Y. (L. R., 234); Thomas E. Miller, Boston, Mass. (L. R., 236); C. S. Smith, Granby, Vt. (L. R., 238); J. H. Blake, New York (L. R., 240); E. McCarthy, Ogdensburg, N. Y. (L. R., 242), and J. W. Provem, Oshawa, Ontario, Canada.

The replies of the recorder to these various communications (Letter Book, pp. 348 to 403, inclusive), were also laid before the board.

After examination, all this correspondence was approved.

The board then adjourned to meet at Governors Island September 16, 1891.

GOVERNORS ISLAND,
New York Harbor, September 16, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

A letter (L. R., 250) was received from P. Everitt, London, England, with reference to a magazine gun of his invention, and an appropriate reply (Letter Book, p. 405) was sent.

The board then proceeded to the test of the Springfield caliber .30, No. 2, concluding the safety test and those for rapidity with accuracy and rapidity at will, and also a portion of the endurance tests, with results as in the synopsis of tests.

The board then adjourned to meet at Governors Island September 17.

GOVERNORS ISLAND,
New York Harbor, September 17, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

Letters were received from Maj. P. T. Godsal, Windsor, England (L. R., 251), and the Hotchkiss Ordnance Company, Washington, D. C.

(L. R., 252), informing the board they would have guns ready for trial about November 1; from Capt. Frank Baker, commanding Frankford Arsenal (L. R., 253), with reference to the cartridges sold to Mr. John Ford, Portneuf Station, Canada; from the Chief of Ordnance, with reference to the cartridges for the Japanese magazine rifle (L. R., 254), and also (L. R., 255) forwarding the request of Capt. T. A. Bingham, United States Engineers, military attaché at Berlin, desiring a copy of the report of the trial of the Mauser gun.

The trial of the Bruce magazine gun (No. 2) was then commenced, the tests being concluded as far as to include those for endurance, with results as stated in the synopsis of tests.

The board then adjourned to September 18.

GOVERNORS ISLAND,
New York Harbor, September 18, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

A letter was sent to Mr. John Ford, Portneuf Station, Canada (Letter Book, p. 408), with reference to the caliber .30 cartridges and barrel he had requested.

The trial of the Springfield caliber .30 single loader (No. 2) was continued, concluding all the regular tests and the first of the supplementary tests, with results as in the synopsis.

The board then adjourned to Monday, September 21.

GOVERNORS ISLAND,
New York Harbor, September 21, 1891.

The board met pursuant to adjournment.

Present. Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

A letter was received from Thomas E. Miller, Boston, Mass. (L. R., 257), inquiring price of caliber .30 barrel. A reply (Letter Book, p. 409) was sent. Letters were received from Thomas B. Wilson, Springfield, Mass. (L. R., 258), submitting drawings of a magazine gun; from H. A. Lewis, Philadelphia, Pa. (L. R., 259), stating he would not have gun ready for the September session of the board, and from Lieut. F. P. Fremont, United States Army, with reference to a magazine gun of which he was informed. To the latter a reply (Letter Book, p. 410) was sent.

A letter was received from Henry W. Blair, Washington, D. C. (L. R., 261), requesting information, and reply (Letter Book, p. 412) sent; a letter from C. S. Smith, Granby, Vt. (L. R., 262), desiring to purchase caliber .30 barrel and cartridges, and action thereon taken (Letter Book, pp. 414 to 417).

A communication was forwarded by the Chief of Ordnance (L. R., 263) from the Acting Secretary of State with reference to the ammunition for the Schmidt (Swiss) rifle, and answer (Letter Book, p. 415) made.

An application from Col. E. A. Carr, Sixth Cavalry, referred to the board by the Adjutant-General of the Army (L. R., 264), to observe the

small arms before the board and to witness their trials, was received and reply made (Letter Book, p. 418).

The trial of the Murata (Japan) magazine gun was commenced and continued, to include the safety test and the regular tests as far as a portion of the endurance test, with results as in the synopsis. The trial of the Bruce magazine gun was resumed, and the piece subjected to the tests for dust, defective cartridges, and excessive charges, with results as in the synopsis.

The Springfield caliber .30 (No. 2) was subjected to the preliminary portion of the rust test.

The board then adjourned until September 22.

GOVERNORS ISLAND,
New York Harbor, September 22, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. Freeman, and Capt. Blunt.

Absent: Maj. McKee, by permission of the board, and Capt. Anderson.

The trial of the Murata (Japan) gun was resumed, the tests for endurance, dust, defective cartridges, and excessive charges being completed, with results as in the synopsis.

The test of the Bruce gun was resumed with the first of the supplementary tests, which was partly completed, with results as in the synopsis.

The board then adjourned to meet on September 23.

GOVERNORS ISLAND,
New York Harbor, September 23, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

A letter (L. R., 266) was received from M. H. Durst, London, England, informing the board he would have a gun ready for trial early in November, and a reply (Letter Book, p. 419) was sent.

A letter was received from the Chief of Ordnance (L. R., 265) forwarding a report of the United States military attaché at Vienna upon a trial of the 6.5^{mm} Mannlicher magazine gun.

The application of Thomas B. Wilson, Springfield, Mass., to have his gun made at the National Armory for trial by the board was considered and action thereon taken (Letter Book, p. 420).

The trial of the Springfield, caliber .30, single loader (No. 2), was resumed; the rust test being concluded, with results as in the synopsis of tests.

The test of the Bruce gun was continued, with the first of the supplementary tests, with results as in the synopsis of tests.

The board then adjourned to meet on September 24.

ARMY BUILDING,
New York City, September 24, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. Freeman, and Capt. Blunt.

Absent: Maj. McKee, by permission of the board, and Capt. Anderson.

There being no guns on hand for trial, and no immediate prospect of any being received, the board adjourned to meet at the Army Building, New York City, on Tuesday, November 3, 1891.

ARMY BUILDING,
New York City, November 3, 1891.

The board met persuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson, in pursuance to a summons to appear as witness before the United States grand jury at Cheyenne, Wyo.

The recorder laid before the board the correspondence conducted by him since the last adjournment. This included a report (Letter Book, p. 422) to the Chief of Ordnance of the transactions of the board since August 17, the date of previous report, and communications (Letter Book, p. 427) addressed to all inventors who, from letters on file, it was inferred, might have guns ready for the November sessions. The following letters received were also laid before the board.

Replies to circular letter above referred to, from the Lee Arms Company, South Windham, Conn. (L. R., 271), and the Winchester Arms Company, New Haven, Conn. (L. R., 272), stating it was only possible their guns would be ready by November; from H. A. Lewis, Philadelphia, Pa. (L. R., 285), stating that owing to personal injury his gun would not be ready; from the Pitcher Automatic Repeating Firearms Company, Neillsville, Wis. (L. R., 275, 284, and 306), stating they expected to have gun ready by November 3, and from Capt. O. Krag, Kongsberg, Norway (L. R., 303), stating that Mr. Jörgensen would leave with their gun for New York on October 29.

With reference to arms of their invention from R. Jennings, Youngstown, Ohio (L. R., 268); James L. Smith, Savannah, Ga. (L. R., 273); August Strehlow, Querida, Colo. (L. R., 274); Richard Woods, Boston, Mass. (L. R., 281); P. Everitt, London, England (L. R., 287), and Thomas B. Wilson, East Boston, Mass. (L. R., 290).

Applications to purchase caliber .30 barrels or cartridges from James L. White, Pittsburg, Pa. (L. R., 269 and 279); James C. Fitzgerald, Pittsburg Pa. (L. R., 270 and 283); Thomas C. Orndorff, Worcester, Mass. (L. R., 286 and 298), and Knoop, Frerichs & Co., New York City (L. R., 296 and 299).

From Alfons Mauser, Hartford, Conn., with reference to primed shells and bullets for his gun (L. R., 278, 282, and 295); and letters submitting various inquiries from Capt. A. H. Russell, Ordnance Department, U. S. Army (L. R., 289); John H. Blake, New York, N. Y. (L. R., 291); J. N. Reese, Springfield, Ill. (L. R., 288); Pitcher Automatic Repeating Firearms Company, Neillsville, Wis. (L. R., 293); Ivert Larsen, Chicago, Ill. (L. R., 297); E. B. Riddle, Allegheny City, Pa. (L. R., 305), and R. H. Howland, Sherwood, N. Y. (L. R., 307).

Communications were received from the Chief of Ordnance transmitting the information that the Italian Government had not yet definitely adopted a magazine small arm (L. R., 267); that the Russian arm was still the subject of experiment, and accounting for the delay in shipment of ammunition for the Swiss gun (L. R., 277), and advising of the sending from Vienna of cartridge frames for the small (6.5^{mm}) Mannlicher (L. R., 300 and 301). Transmitting the results of the analysis of

certain smokeless powders (L. R., 302), and with reference to the loading of cartridges for the Mauser gun (L. R., 304), and also the following letter:

ORDNANCE OFFICE, WAR DEPARTMENT.
Washington, D. C., September 29, 1891.

GENTLEMEN: I have the honor to request, if the information can be given with propriety, that this office may be furnished with the results of tests to which the Springfield .30 caliber, single-loading arm, has thus far been subjected by the board.

I would also be glad to learn, if it be not objectionable to the board to give it, the opinion of the board as to the merits of this gun and its ammunition, regarded simply as a single-loading small arm.

Respectfully,

D. W. FLAGLER,
Brig. Gen., Chief of Ordnance.

The BOARD ON MAGAZINE ARMS,
Army Building, New York City.

To this communication, after correspondence between the members of the board, the following reply was sent:

OFFICE OF THE BOARD ON MAGAZINE ARMS,
NATIONAL ARMORY,
Springfield, Mass., October 13, 1891.

To the CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.:

SIR: In reply to your letter of the 29th ultimo to the Board on Magazine Arms I have the honor to inclose, by direction of the board, the synopsis of the tests of the Springfield caliber .30 single loader No. 1, made between May 15 and 18, and that of No. 2, made between September 16 and 23, 1891, and as a separate report the conclusions of the board drawn therefrom.

Very respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord. Dept., U. S. A., Recorder.

Report upon the trials of the caliber .30 Springfield single loaders Nos. 1 and 2 and the Frankford Arsenal experimental cartridge.

No. 1 differs from the service .45 only so far as is made necessary by the reduction of caliber.

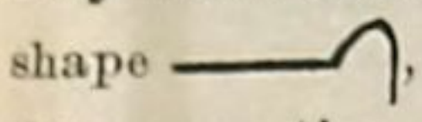
No. 2 differs from No. 1 in the following particulars:

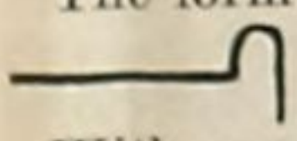
The well of the receiver is slightly and gradually deepened from the rear of the ejector stud to the seat of the breech screw and it has also a small vertical cut at its forward end under the counterbore. These two changes were made to afford space for the unburnt powder grains and to facilitate their removal.

The extractor is altered so that its bearing surface on the cartridge head is much increased and the cutting effect noticed in the trials of No. 1 is avoided.

Externally the receiver no longer tapers from rear to front, but is made straight; this thickens and strengthens the gun over the chamber; also strengthens the ears and affords better support for the extractor.

The chamber, the well of the receiver (with the exceptions mentioned) the counterbore, and head space are identical in the two guns.

Gun No. 1 generally worked well, except that the extractor in some cases tore through the cartridge head, leaving the empty shell in the chamber. In the opinion of the board this defect was partly chargeable to the extractor, bearing as it did only with a small surface, and partly to the form of the head, which, being of this shape  , permitted the extractor to ride up on it and then cut through at its thinner portion.

The form of the head was subsequently modified at Frankford to this shape  .

With gun No. 2 the improved heads were used, and, in combination with the improved extractor, worked well.

In some cases the shell was not ejected when the chamber was foul, and also occasionally when the muzzle was lowered as the breechblock was opened, the flip of the extractor being too slight. This defect, however, it is believed can be readily remedied.

The greatest defect observed in the trial of No. 2 was the frequent failure of the thumb piece of the cam latch to close without pressure from the hand, thus necessitating a separate motion to seat the cam.

In the opinion of the board this defect is partly chargeable to the manner in which the cartridge is by the breechblock pushed into the chamber, the mechanism being susceptible to the influence of dust, fouling, or unburned powder in the chamber or receiver. But it was undoubtedly also caused by the unusual amount of unburnt grains of the Wetteren powder, which, collecting in the chamber, in the receiver next the counterbore, and in the receiver in front of the cam recess, prevented the easy insertion of the cartridge or the seating of the cam. When the gun was clean this defect was not apparent, but after a few (15 or 20) shots the accumulation of unburnt powder was sufficient to compel a separate motion and pressure on the thumb piece to seat the cam.

With a powder entirely consumed it is probable the cam would have been seated, though it must be mentioned that the dust test also produced the same trouble.

With gun No. 2 the block was opened with difficulty in the test with excessive charges.

Comparing the gun with the Bruce No. 1 and No. 2, and the Murata (Japan) magazine bolt guns, which were tested with the same Wetteren cartridges, it was observed that the unburnt grains and fouling did not materially interfere with the complete introduction of the cartridge and the closing and locking of the bolt, the amount and direction of the power applied easily overcoming the resistance offered by the unburnt grains.

Comparing the Springfield with the fire as single loaders of the different magazine guns so far tested by the board, it is observed that it is more rapid than some (the Belgian Mauser and German infantry, for instance, which are intended for only magazine fire, and in which for single-loader fire the cartridges must be introduced with care in consequence of the form of the floor of the receiver), but that it is slower than others, the Lee and Krag-Jörgensen, for instance, which are adapted for use as single loaders with the magazine held in reserve and in which (as in the Springfield) the floor of the receiver is well closed.

This is shown by the following table:

Arms.	Accuracy for two minutes. (Number of shots.)	At will for one minute. (Number of shots.)	Remarks.
Lee-Speed	49	28	
Krag-Jörgensen	42	28	
Springfield No. 1	36	24	Test II b.
Springfield No. 2	35	17	See synopsis of tests of No. 2.

As to the cartridges used by the board, mention has already been made of the fact that grains of partially or entirely unburned powder were left in the chamber, some of which, as the shell is withdrawn, collect in the receiver.

The board understands that smokeless powders have been tested at the Springfield Armory which are free, or nearly so, from this defect, so noticeable with the Wetteren.

With the Frankford experimental cartridges, which were used by the board, numerous cases of bullets keyholing at the short range of 20 to 100 feet, due to a stripping of the jacket, were also observed, both when the cartridge was fired from the Bruce and from the Springfield guns. This stripping was not noticed with any of the following ammunition:

Lee-Speed, nickel jacket, no lubrication.
Krag-Jörgensen, copper jacket, exterior lubrication.
Mannlicher, nickel jacket, no lubrication.
Kropatschek, nickel jacket, exterior lubrication and interior lubricating wad.
Mauser, German silver jacket, no lubrication.
German infantry, German silver jacket, no lubrication.
Murata, copper jacket, no lubrication.
None of the above bullets have cannelures.

An experience of many years in the hands of troops has unquestionably proved that the breech action of the Springfield caliber .45, in connection with a cartridge suited to it, provides an efficient mechanism for a single loader.

The limited number and simplicity of its parts, its ability to stand rough usage, and the ease with which recruits can learn to operate the gun are merits which previous boards have accorded it over a number of bolt-action guns; a judgment in which this board, as far as its present experience warrants any conclusion, concurs.

The slight changes made in adapting the mechanism of the .45 to the .30 caliber Springfield are only those which should add to the strength of the arm, and it is not seen why, if used with a cartridge thoroughly adapted in all particulars to its

mechanism, all parts should not work as smoothly and easily as those of the present service arm.

But with the Frankford experimental cartridge loaded with Wetteren powder as used by the board, the two defects of unburnt powder grains and stripping jackets make the combination of arm and cartridge unsatisfactory, and the board believes it would, as it now stands, be universally condemned in service.

To the above, which in every particular is concurred in by Col. Hall, Maj. Freeman, and Capt. Blunt, Maj. McKee adds the following:

It concur in the above progress report in every particular, with the exception of the remarks anent the Frankford Arsenal experimental cartridge.

It would give the impression from the terms of the statement that the cartridge, which is simply being carefully experimented with and perfected from the best information in the world, was a total failure.

The cartridge *per se* is a case containing a charge for a firearm. It is as a factor in the firing result in no way responsible for every explosive with which it may be charged.

The case is made to resist the explosive action of certain compounds and is calculated to resist certain pressures. It seems hardly necessary to dwell upon a thing so patent, but the experimental case or cartridge made here should not be held to depend upon the irregularity of the Wetteren powder as regards pressure and its failure to thoroughly burn.

It was expected that some of the bullets would keyhole and the copper strip in the progress of experimenting with and perfecting this cartridge, but of the last lot made 1,000 were fired before a single incident of this kind happened.

Upon this Capt. Blunt remarks as follows:

The term cartridge in the preceding report has not been understood to mean only the case, but the combination as introduced in the chamber of the gun; that is, the case, the bullet, and the powder.

As the report says, the case with the improved head appears to be entirely satisfactory. With the bullets used by the board there were numerous cases of stripping jackets, causing the bullet to keyhole in the butt. I believe, with Maj. McKee, that this difficulty can be overcome.

The Wetteren powder, though answering fairly well for bolt-action guns, is not suited for use in cartridges intended for the Springfield arm. Of course, I believe that a suitable smokeless powder will ultimately be forthcoming.

Beyond these two statements I by no means intended to give the impression that the cartridge "was a total failure."

The Chief of Ordnance asked the opinion of the board "as to the merits of this gun and its ammunition." Col. Hall, Maj. Freeman, and myself agree that it is a satisfactory arm, and so far Maj. McKee expresses his concurrence; but the first three add that the ammunition used by the board did not prove satisfactory for the gun, and if the gun and this ammunition were issued to the Army the latter would in service lead to the condemnation of the gun, though the ammunition itself would be the element really at fault.

Respectfully submitted.

S. E. BLUNT,
Capt., Ord. Dept., Member and Recorder of the Board.

A letter (L. R., 292) from the Chief of Ordnance, with reference to some of the prescribed tests, was also laid before the board.

After a careful examination and discussion of all these letters and the replies (Letter Book, pp. 422 to 504, inclusive) of the recorder thereto, made since the last session, the entire correspondence was approved by the board.

The board then adjourned to meet on November 4 at Governors Island.

GOVERNORS ISLAND,
New York Harbor, November 4, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

A letter (L. R., 308) was received from P. Everitt, London, England, with reference to the gun he desired to submit, and one making various inquiries (L. R., 309) from Daniel Hug, Denver, Colo. A reply (Letter Book, p. 505) was made to the latter, and also (Letter Book, p. 507) to the communication from the Chief of Ordnance with reference to tests.

Dr. Pitcher not appearing with his rifle as expected, a telegram (Letter Book, p. 508) was sent to Alfons Mauser, Hartford, Conn., informing him the board would commence the test of his gun on the following day.

The board then adjourned to meet on November 5.

GOVERNORS ISLAND,
New York Harbor, November 5, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

The letter from Daniel Hug was returned by indorsement (Letter Book, p. 510) to the Adjutant-General of the Army.

The trial of the Mauser gun No. 2 was then commenced, and the safety test and the regular tests as far as those for endurance were completed. The weather being very inclement, further firing was suspended. Subsequently a telegram (L. R., 310) was received from Mr. Alfons Mauser and a reply (Letter Book, p. 511) sent.

The board then adjourned until the 6th instant.

GOVERNORS ISLAND,
New York Harbor, November 6, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

A letter (L. R., 311) was received from Ivert Larsen, Chicago, Ill., inquiring as to the size of the caliber .30 barrels sold to inventors, and a suitable reply (Letter Book, p. 512) sent.

Dr. H. A. Pitcher appeared before the board and stated that an injury to his gun had prevented its being ready for trial.

Mr. Alfons Mauser appeared before the board and remained as a witness of the test of the Mauser No. 2, which was then resumed, the tests for endurance and dust being concluded, and that for defective cartridges begun, with results as in the synopsis of tests.

The board then adjourned to meet at the Army Building November 7.

ARMY BUILDING,
New York City, November 7, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. Freeman, and Capt. Blunt.

Absent: Maj. McKee, by permission of the board, and Capt. Anderson.

Dr. H. A. Pitcher appeared and exhibited his gun and explained its mechanism; but not being in condition for test, it was temporarily withdrawn.

A letter (L. R., 312) was received from T. B. Wilson, East Boston, Mass., with reference to his gun, which, after consideration, was temporarily laid aside.

The board then adjourned until Monday, November 9.

ARMY BUILDING,
New York City, November 9, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Majs. McKee and Freeman, and Capt. Blunt.

Absent: Capt. Anderson.

A letter (L. R., 313) was received from Frank H. Mayer, Cortez, Colo., making inquiries about caliber .30 barrels, and a reply (Letter Book, p. 514) sent.

The letter of Mr. Thomas B. Wilson, received on the 7th instant, was further considered and forwarded by indorsement (Letter Book, p. 518) to the Chief of Ordnance.

Mr. Jörgensen not having arrived from Norway, and there being no other guns awaiting test, the board adjourned until the 10th instant.

ARMY BUILDING,
New York City, November 10, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. Freeman, and Capt. Blunt.

Absent: Maj. McKee, attending a session of the board for testing rifle cannon, and Capt. Anderson.

A letter was received from Capt. O. Krag, Kongsberg, Norway (L. R., 315), stating that Mr. Jörgensen would sail on October 29, on the Danish steamer *Hekla;* a letter from M. H. Durst, London, England (L. R., 314), stating he would have guns ready to present in December, and one (L. R., 316) from the commanding officer, National Armory, transmitting certain information received from the Ordnance Office with reference to a foreign small arm.

The steamer *Hekla* not being due until Saturday, November 14, and there being no other guns awaiting test, the board adjourned to meet at the Army Building on Monday, the 16th instant.

ARMY BUILDING,
New York City, November 16, 1891.

The board met pursuant to adjournment.

Present: All the members.

The recorder laid before the board the letters received since the last adjournment. These included requests (L. R., 317 and 319) from the Winchester Arms Company, New Haven, Conn., to purchase caliber .30 cartridges, and an inquiry (L. R., 318) from Isidor Freedman, New Haven, Conn., as to when he could submit the gun of Maj. P. T. Godsal, whom he represented.

The letters sent by the recorder (Letter Book, pp. 519 to 528, inclusive) were also submitted. After examination, this correspondence was approved by the board.

A letter (L. R., 320) was received from J. W. Mullins, Fariston, Ky., desiring to purchase a caliber .30 barrel and cartridges, and proper action (Letter Book, pp. 529, 531, and 532) taken thereon.

Lieut. H. J. White, Marine Corps, U. S. Navy, appeared and explained a model of a magazine gun of his invention.

Capt. R. M. Petersen and Mr. E. Jörgensen, from Kongsberg, Norway, brought before the board the Krag-Jörgensen rifle, adapted to the Frankford Arsenal experimental caliber .30 cartridge, and also another arm of the same caliber, but chambered for a different shell. Primed shells of the latter form were sent to the Frankford Arsenal to be loaded, and the tests of the former arm commenced and continued, to include a portion of the test for rapidity at will.

The board then adjourned to the 17th instant.

ARMY BUILDING,
New York City, November 17, 1891.

The board met pursuant to adjournment.

Present: All the members.

The weather being too inclement for the prosecution of tests at Governors Island, the board adjourned to the 18th instant.

GOVERNORS ISLAND,
New York Harbor, November 18, 1891.

The board met pursuant to adjournment.

Present: All the members.

The test of the Krag-Jörgensen No. 2 was then resumed and continued through the tests for rapidity at will, with results as in the synopsis of tests.

With permission of the board the gun was then withdrawn for some slight corrections, and the board adjourned to meet on the 19th instant.

ARMY BUILDING,
New York City, November 19, 1891.

The board met pursuant to adjournment.

Present: All the members.

The modification in the Krag-Jörgensen No. 2 not having been completed, and several days being necessary yet for the work, the board adjourned to meet at the Army Building, New York City, on Monday, November 23, 1891.

ARMY BUILDING,
New York City, November 23, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. Freeman, Capts. Blunt and Anderson.

Absent: Maj. McKee, detained at Frankford Arsenal on official business.

The recorder laid before the board the correspondence conducted by him since the last adjournment. This included a letter, making various inquiries (L. R., 323), from R. Jennings, Youngstown, Ohio, and the reply thereto (Letter Book, p. 540); also, letters to the Lee Arms Company (Letter Book, pp. 537 and 538) and to seventeen other inventors or manufacturers which it was believed were preparing guns for trial, informing them of the sessions of the board to be held at the armory in December and January, and inquiring whether their guns would then be ready for test.

After examination this correspondence was approved.

The necessary correction having been made in the Krag-Jörgensen gun, the arm as modified was again brought before the board by Capt. R. M. Petersen and Mr. E. Jörgensen, from Kongsberg, Norway, and entered on the docket as Krag-Jörgensen No. 3.

The weather being too inclement to conduct tests at Governors Island, the board adjourned to the 24th instant.

GOVERNORS ISLAND,
New York Harbor, November 24, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. Freeman, and Capts. Blunt and Anderson.

Absent: Maj. McKee, detained at Frankford Arsenal on official business.

A letter (Letter Book, p. 542) was addressed to the commanding officer Fort Columbus, thanking him for facilities accorded the board, and desiring that the stop butt in the ditch be not removed. Also a letter (Letter Book, p. 541) requesting the commanding officer New York Arsenal to ship to the Springfield Armory all the materials used by the board in tests of guns.

The trial of the Krag-Jörgensen No. 3 was then commenced, the safety test, all the regular tests, and the first of the supplementary tests completed, with results as in the synopsis of tests.

The board then adjourned to meet on the 25th instant.

ARMY BUILDING,
New York City, November 25, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Maj. Freeman, and Capts. Blunt and Anderson.

Absent: Maj. McKee, detained at Frankford Arsenal on official business.

After a discussion of the previous trials, and it being impracticable to conduct further tests at Governors Island, the board adjourned to meet at the National Armory, Springfield, Mass., on December 2, 1891.

NATIONAL ARMORY,
Springfield, Mass., December 2, 1891.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Capts. Blunt and Anderson.

Absent: Maj. Freeman, by permission of the board.

The death of Maj. McKee, at Frankford Arsenal, Pa., on November 30, 1891, was announced.

The recorder laid before the board the letters received since the last adjournment. These included a letter (L. R., 332) from John W. Blake, Dalton, Ga., desiring to purchase a caliber .30 barrel and cartridges, and letters (L. R., 325 to 338) from eleven inventors, two stating they would have guns ready for January, two stating they would possibly be ready, and the remainder that they would not be prepared for some time.

Letters sent by the recorder (Letter Book, pp. 545 to 554, inclusive) were also submitted. After examination, all the correspondence was approved by the board.

A letter (L. R., 339) was received from T. C. Orndorff, Worcester, Mass., transmitting a sample Mills belt for caliber .30 cartridges.

The trial of the Krag-Jörgensen No. 4 was then commenced, the safety test, those for rapidity with accuracy and at will, for endurance and dust, and a portion of the defective cartridge test being completed, with results as in the synopsis of tests.

The Krag-Jörgensen No. 3, which, in anticipation of the meeting of the board, had by the recorder, on November 30, been subjected to the preliminary portion of the rust test, was examined, and the amount of rusting being deemed insufficient the preliminary portion of the test was repeated.

The board then adjourned to meet on the 3d instant.

NATIONAL ARMORY,
Springfield, Mass., December 3, 1891.

The board met pursuant to adjournment.

Present: All the members.

The test of the Bruce gun No. 4 with magazine No. 2 was commenced and continued to include the safety test, those for rapidity with accuracy and rapidity at will, endurance and dust, with results as in the synopsis of tests.

The rust test of the Krag-Jörgensen No. 3 was concluded, with results as in the synopsis of tests.

The Krag-Jörgensen No. 4 was withdrawn for alterations. A letter (Letter Book, p. 555) was sent to the commanding officer Frankford Arsenal, requesting the sale of 1,000 bullets and primed shells, caliber .30, to the representatives of the Krag-Jörgensen gun.

The board then adjourned to meet on the 4th instant.

NATIONAL ARMORY,
Springfield, Mass., December 4, 1891.

The board met pursuant to adjournment.

Present: All the members.

A letter (L. R., 341) was received from R. M. Catlin, Providence, R. I., inquiring how much further time the board would allow him for the completion of his magazine gun, and a reply (Letter Book, p. 556) sent.

Replies (Letter Book, pp. 557 to 563) were also made to similar inquiries previously received from several other inventors, and they were also informed of the date selected for the next meeting of the board.

There being no other guns awaiting test, and none being expected for several weeks, the board then adjourned to meet at the National Armory on January 19, 1892.

NATIONAL ARMORY,
Springfield, Mass., January 19, 1892.

The board met pursuant to adjournment.
Present: Lieut. Col. Hall, Maj. Freeman, Capts. Blunt and Anderson.
The following order was received:

SPECIAL ORDERS, No. 284.

HEADQUARTERS OF THE ARMY,
ADJUTANT-GENERAL'S OFFICE,
Washington, December 7, 1891.

[Extract.]

* * * * * * *

8. By direction of the Secretary of War Maj. James W Reilly, Ordnance Department, is detailed as a member of the board of officers convened by General Orders No. 136, November 24, 1890, from this office, at the Army Building, New York City, to consider and recommend a suitable magazine system for rifles and carbines for the military service, vice Maj. George W. McKee, Ordnance Department, deceased.

* * * * * * *

By command of Maj. Gen. Schofield.

J. C. KELTON,
Adjutant-General.

Official:
J. C. GILMORE,
Assistant Adjutant-General.

Maj. Reilly, who was present, accordingly took his seat as a member of the board.

The recorder laid before the board the correspondence conducted by him since the last adjournment. This included a report (Letter Book, pp. 564 to 570, inclusive) to the Chief of Ordnance of the transactions of the board between September 25 and December 4, 1891, and communications from the following:

Requests for sample cartridges and for information on various points, from R. M. Catlin, Providence, R. I. (L. R., 345); W. E. Mason, Chicago, Ill. (L. R., 348); J. W. Mullins, Fariston, Ky. (L. R., 350 and 378); John Jett, San Francisco, Cal. (L. R., 361); G. L. Putnam, San Francisco, Cal. (L. R., 368); J. W. Blake, Dalton, Ga. (L. R., 371 and 390); Don D. Miles, Aurora, Ill. (L. R., 379); Alfonso Mercer, Norfolk, Va. (L. R., 381); Browning Bros., Ogden, Utah (L. R., 382); C. D. Weldon, Mica, Wash. (L. R., 385); S. D. Locke, Hoosick Falls, N. Y. (L. R., 393), and F. E. Fuller, Taunton, Mass. (L. R., 395, 396, and 399).

A letter, indorsing Mr. Miles, mentioned above, from Hon. A. J. Hopkins, M. C. (L. R., 384).

Letters desiring to purchase caliber .30 barrels or cartridges from Arthur Savage, Utica, N. Y. (L. R., 347 and 359); Remington Arms Company, New York (L. R., 367 and 370); Winchester Arms Company, New Haven, Conn. (L. R., 372 and 374); R. H. Howland, Sherwood, N. Y. (L. R., 373), and Ivert Larsen, Chicago (L. R., 391).

Communications with reference to magazine arms they were preparing for submission to the board, from J. C. Fitzgerald, Pittsburg, Pa. (L. R., 343); Lee Arms Company, South Windham, Conn. (L. R., 344, 376, 387, 398, and 404); M. H. Durst, London, England (L. R., 352, 356, and 388); J. H. Acton, Aurora, Ill. (L. R., 357); Knoop, Frerichs & Co., New York (L. R., 358); J. W. Mullins, Fariston, Ky. (L. R., 365); Pitcher Arms Company, Neillsville, Wis. (L. R., 369, 377, and 401); Hotchkiss Ordnance Company, Washington, D. C. (L. R., 375, 386, and 403); C. S. Smith, Granby, Vt. (L. R., 380); Alfons Mauser, Hartford, Conn. (L. R., 351 and 389); John Ford, Portneuf, Province of Quebec, Canada (L. R., 392 and 400); E. B. Riddle, Allegheny City, Pa. (L. R., 394), and John R. Dos Passos, New York (L. R., 402).

With reference to drawings of magazine arms they had devised, from H. B. Forbes, Ogden, Utah (L. R., 363), and W. G. Gray, Ashland City, Tenn. (L. R., 383).

From Isidor Freedman, New Haven, Conn. (L. R., 354 and 366), submitting the rifle of Maj. P. T. Godsal, of Windsor, England.

From Capt. R. M. Petersen, royal Norwegian navy (retired), representing the Krag-Jörgensen magazine arms (L. R., 349), requesting copy of the synopsis of the tests of those guns.

From the Chief of Ordnance, U. S. Army, making allotment of funds for payment of clerk, etc., for the board until June 30, 1892 (L. R., 355); transmitting notes on the new Russian small arm (L. R., 342), and cartridge packets for and pamphlet description of the German magazine arm (L. R., 362 and 364), and letters from the commanding officer Frankford Arsenal (L. R., 346, 360, and 397) with reference to caliber .30 cartridges.

The various letters of the recorder in reply to or acting upon the above communications (Letter Book, pp. 571 to 653, inclusive) were also laid before the board.

After examination, all this correspondence was approved by the board.

Mr. Laurence V. Benét, representing the Hotchkiss Ordnance Company, then submitted to the board three Berthier rifles, caliber .30; and the gun from the Pitcher Arms Company, Neillsville, Wis., having been received by express, was also brought before the board.

All these guns were then carefully examined and their apparent merits discussed; after which, the weather being too inclement for actual tests, the board adjourned to the 20th instant.

NATIONAL ARMORY,
Springfield, Mass., January 20, 1892.

The board met pursuant to adjournment.

Present: All the members.

A letter was received from Capt. A. H. Russell, Ordnance Department (L. R., 405), stating he would be ready to submit the Russell-Livermore gun to the board on the 22d instant; also a letter from S. I. Scott, Washington, D. C. (L. R., 406), desiring to purchase a caliber .30 barrel and 100 cartridges.

Suitable action on these communications (Letter Book, pp. 654 to 658) was taken.

The board then proceeded to the test of the Berthier No. 1, the safety test and the first of the regular tests being prosecuted with results as in the synopsis of tests.

The Pitcher gun was then taken up, the safety test and certain other tests as given in the synopsis being conducted.

The board then adjourned until the 21st instant.

NATIONAL ARMORY,
Springfield, Mass., January 21, 1892.

The board met pursuant to adjournment.

Present: All the members.

A letter was received from F. E. Fuller, Taunton, Mass. (L. R., 407), making various inquiries, and reply (Letter Book, p. 659) sent.

A telegram was received from Capt. A. H. Russell, Ordnance Department (L. R., 408), stating he would appear before the board on the morning of the 22d instant.

The tests of the Berthier No. 2 were commenced, the safety test and a portion of the regular tests being prosecuted with results as in the synopsis.

The test of the Pitcher gun was resumed, a portion of the endurance test being conducted with results as in the synopsis of tests.

The board then adjourned until the 22d instant.

NATIONAL ARMORY,
Springfield, Mass., January 22, 1892.

The board met pursuant to adjournment.

Present: All the members.

Capt. A. H. Russell, Ordnance Department, appeared before the board and submitted three guns of his invention. As, however, they were not of caliber .30, but of caliber .45, and not in condition for firing, no tests could be made, Capt. Russell merely explaining their mechanism to the board.

There being no other guns awaiting test, or any other business requiring action, the board adjourned to meet at the National Armory on February 23, 1892.

NATIONAL ARMORY,
Springfield, Mass., February 23, 1892.

The board met pursuant to adjournment.

Present: Lieut. Col. Hall, Lieut. Col. Farley, Maj. Freeman, and Capts. Blunt and Anderson.

Lieut. Col. Farley relieved Maj. Reilly as a member of the board in accordance with the following orders:

SPECIAL ORDERS, No. 17.

HEADQUARTERS OF THE ARMY,
ADJUTANT-GENERAL'S OFFICE,
Washington, January 21, 1892.

[Extract.]

* * * * * * *

14. By direction of the Secretary of War the following changes in the stations and duties of officers of the Ordnance Department are ordered:

* * * * * * *

Lieut. Col. Joseph P. Farley is assigned to the command of the Frankford Arsenal, Pennsylvania, and is detailed as a member of the Board on Magazine Arms convened by General Orders, No. 136, November 24, 1890, from this office; and he will also take temporary charge of the United States powder depot, Dover, N. J.

* * * * * * *

Maj. James W. Reilly is relieved from the command of the United States powder depot, Dover, N. J., and as a member of the board on magazine arms convened by General Orders No. 136, November 24, 1890, from this office, and is assigned to the command of the Watertown Arsenal, Massachusetts.

* * * * * * *

The officers named, whose stations are changed, will proceed to join the stations assigned them. The travel enjoined is necessary for the public service.

By command of Maj. Gen. Schofield.

J. C. KELTON,
Adjutant-General.

Official:
J. C. GILMORE,
Assistant Adjutant-General.

The recorder laid before the board the communications received since the last adjournment. These included inquiries as to how much further time would be allowed inventors, and request for information on various points from the following:

Thomas A. Fletcher, Burlington, Iowa (L. R., 413); Wilford Hill, Waltham, Mass. (L. R., 414); Philip P. Leche, Erie, Pa. (L. R., 418 and 436); John W. Blake, Dalton, Ga. (L. R., 419); F. E. Fuller, Taunton, Mass. (L. R., 423, 441, 466, and 483); George L. Putnam, San Francisco, Cal. (L. R., 424); J. W. Mullins, Fariston, Ky. (L. R., 426); Alfons Mauser, Hartford, Conn. (L. R., 427 and 438); F. W. Tyrer, Washington, D. C. (L. R., 435); Richard Woods, Boston, Mass. (L. R., 437); Lewis Altmaier, Philadelphia, Pa. (L. R., 442); Walter G. Gray, Ashland City, Tenn. (L. R., 459); W. H. Harwick, Ceres, Cal. (L. R., 461); E. M. Patten, Yuma, Colo. (L. R., 468 and 474); Thomas B. Wilson, East Boston, Mass. (L. R., 471), and Arthur Savage, Utica, N. Y. (L. R., 472).

Requests to purchase caliber .30 barrels of cartridges from Don D. Miles, Aurora, Ill. (L. R., 415); the Hotchkiss Ordnance Company, Washington, D. C. (L. R., 416 and 444), and Thomas B. Wilson, East Boston, Mass. (L. R., 449).

Letters with reference to guns they proposed to submit, from M. H. Durst, London, England (L. R., 412, 454, and 464); Capt. A. H. Russell, U. S. Army (L. R., 431), and the Hotchkiss Ordnance Company (L. R., 476 and 482). From the commanding officer Frankford Arsenal, with reference to caliber .30 cartridges for use of the board or of inventors (L. R., 410, 422, 460, and 473). From the Chief of Ordnance, forwarding reports from the United States military attaché at Berlin (L. R., 417), with reference to the new Italian rifle; the United States military attaché at London, with reference to the Lee-Metford (L. R., 420), and the United States military attaché at Vienna, with reference to the Mannlicher carbine (L. R., 421).

Letters stating they would not submit guns to the board, from James Duane, New York, N. Y. (L. R., 429); W. H. Elliott, Brooklyn, N. Y. (L. R., 432); D. Hug, Denver, Colo. (L. R., 456), and Riley Bowers, Springfield, Ill. (L. R., 445).

Letters stating their guns would not be ready for the February session, but that they hoped to have them before June 1, 1892, from the following: F. E. Fuller, Taunton, Mass. (L. R., 430); Knoop, Frerichs & Co., New York (L. R., 433); Winchester Arms Company, New Haven, Conn. (L. R., 434); Arthur Savage, Utica, N. Y. (L. R., 439); A. Mercer, Norfolk, Va. (L. R., 440); Don D. Miles, Aurora, Ill. (L. R., 443); John W. Blake, Dalton, Ga. (L. R., 446); S. I. Scott, Washington, D. C. (L. R., 447), J. H. Acton, Aurora, Ill. (L. R., 448); A. Burgess, Buffalo, N. Y. (L. R., 450); A. W Roovers, Brooklyn, N. Y. (L. R., 451); C. S. Smith, Granby, Vt. (L. R., 452); Ivert Larsen, Cook County, Ill. (L. R., 453); Thomas A. Fletcher, Burlington, Iowa (L. R., 455); H. H. Cummings & Co., Boston, Mass. (L. R., 457); J. W. Mullins, Fariston, Ky. (L. R., 458); J. C. Fitzgerald, Pittsburg, Pa. (L. R., 462); James L. White, Pittsburg, Pa. (L. R., 465); John Jett, San Francisco, Cal. (L. R., 467); James L. Smith, Savannah, Ga. (L. R., 469); John Ford, Portneuf, Canada (L. R., 470); August Strehlow, Querida, Colo. (L. R., 478); Charles D. Weldon, Mica, Wash. (L. R., 479); W E. Blackburn, Anthony, Kans. (L. R., 480), and Capt. A. H. Russell, U. S. Army (L. R., 481).

The following letter was received from the Secretary of War:

WAR DEPARTMENT,
Washington, January 25, 1892.

SIR: It is important that the Government should have the results of the investigations of the Board on Magazine Arms at an early date It is understood that the work of the board has been delayed by the delays of inventors in presenting their arms to the board.

Unless authorized by this Department you will not receive arms for trial after June 1, 1892, and the board will then complete its labors and forward its report as soon as practicable.

Please have all parties that you think intend to present arms notified of the above decision, and if you deem it necessary to have the information published in any newspapers, make the usual application for authority for the same.

Respectfully,

S. B. ELKINS,
Secretary of War.

The PRESIDENT OF THE BOARD ON MAGAZINE ARMS,
Army Building, New York, N. Y.

The recorder laid before the board the following letter (Letter Book, p. 684), which had been sent to all the firms or individuals (88 in number) who had been in correspondence with the board.

OFFICE OF THE BOARD ON MAGAZINE ARMS,
NATIONAL ARMORY,
Springfield, Mass., February 3, 1892.

DEAR SIR: Your attention is invited to the following extract from a letter received here to-day from the War Department:

"WAR DEPARTMENT,
"*Washington, January 25, 1892.*

"SIR: It is important that the Government should have the results of the investigations of the Board on Magazine Arms at an early date. It is understood that the work of the board has been delayed by the delays of inventors in presenting their arms to the board.

"Unless authorized by this Department you will not receive arms for trial after June 1, 1892, and the board will then complete its labors and forward its report as soon as practicable.

* * * * * * *

"Respectfully,

"S. B. ELKINS,
"*Secretary of War.*

"The PRESIDENT OF THE BOARD ON MAGAZINE ARMS."

The next session of the board will be held at this armory commencing on February 23, 1892, and will continue as long as any guns remain on hand awaiting test.

Please inform me whether you will present a gun at that session.

Subsequent sessions will also be held, of which you will be duly informed as to the time and place of meeting, if you so desire.

Respectfully,

S. E. BLUNT,
Capt., Ord. Dept., Recorder.

The following letter (L. R., 428) from the Chief of Ordnance was laid before the board:

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, D. C., February 4, 1892.

SIR: You will please prepare at your earliest convenience and submit for the information of this office a report upon the sights and bayonets used upon the magazine small arms of different foreign nations.

Respectfully,

D. W. FLAGLER,
Brigadier-General, Chief of Ordnance.

The RECORDER OF THE BOARD ON MAGAZINE ARMS,
Springfield Armory, Springfield, Mass.

The replies of the recorder (Letter Book, pp. 661 to 729) to these various communications were also submitted. These included a report (Letter Book, p. 661) of the transactions up to January 23, 1892, and the following letter (Letter Book, p. 704):

OFFICE OF THE BOARD OF MAGAZINE ARMS,
NATIONAL ARMORY,
Springfield, Mass., February 9, 1892.

SIR: On July 6, 1891, request was submitted for the new Russian and Italian magazine small arms.

Under date of October 1, 1891, the Chief of Ordnance informed the board that the Russian Government was then unable to grant the request, and under date of September 23, 1891, that it was not practicable at that time to procure a sample of the Italian gun.

Since then, by Capt. Bingham's report of December 12, 1891 (copy furnished by the Ordnance Office, January 26, 1892), it is learned that six Italian regiments have been furnished with that new rifle for trial.

In view of the fact that seven months have elapsed since the board first expressed its desire for these guns, and that their tests will terminate soon after June 1 next, it is requested that effort be again made to obtain these arms with their ammunition as originally requested last July.

Very respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord. Dept., U. S. A., Recorder.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

After examination, all this correspondence was approved by the board.

The board then proceeded to the test of the Mannlicher carbine, adopted for the armament of the Austro-Hungarian army, the safety and regular tests, and a portion of the supplementary tests being concluded, with results as in the synopsis of tests.

A letter (Letter Book, p. 730) was sent to Capt. A. H. Russell, and one (Letter Book, p. 731) to F. E. Fuller, Taunton, Mass., in reply to inquiries received from them on the 22d instant.

The board then adjourned until the 24th instant.

NATIONAL ARMORY,
Springfield, Mass., February 24, 1892.

The board met pursuant to adjournment.

Present: All the members.

Letters making various inquiries were received from J. C. Sturgeon, Erie, Pa. (L. R., 485); Browning Bros., Ogden, Utah (L. R., 486), and E. S. Dorr, Boston, Mass. (L. R., 487).

The following letter (Letter Book, p. 732) was sent:

OFFICE OF THE BOARD ON MAGAZINE ARMS,
NATIONAL ARMORY,
Springfield, Mass., February 24, 1892.

SIR: While by the orders (General Orders 136, Headquarters of the Army, of November 24, 1890) appointing the Board on Magazine Arms it is required generally that arms submitted must use the Frankford Arsenal experimental cartridge, discretion is given the Chief of Ordnance to submit other arms.

Accordingly a variety of small arms has been brought before the board, some of which take cartridges having a grooved or cannelured head instead of the flanged head of the Frankford shell.

Of the mechanism of some of these guns the board thinks highly, but as difficulty might be experienced in adapting them to a cartridge with a flanged shell, they would, under the board's orders, be excluded from consideration.

Believing that caliber .30 arms using exclusively these cannelured-headed shells, as well as those with flanges, should be considered, and that inventors should have

the opportunity to present such arms, and being of the impression that such cartridges are now approved of by the Chief of Ordnance, the board has the honor to recommend that its instructions be modified in such a manner as may be considered necessary to accomplish the object desired.

Very respectfully, your obedient servant,

ROBT. H. HALL,
Lieut. Col. Sixth Infantry, President of the Board.

ADJUTANT-GENERAL U. S. ARMY,
Washington, D. C.

There being no further business before it, the board then adjourned until the 25th instant.

NATIONAL ARMORY,
Springfield, Mass., February 25, 1892.

The board met pursuant to adjournment.

Present: All the members.

Replies (Letter Book, pp. 734 and 735) were sent to the communications received yesterday.

A letter of inquiry was received from Horace A. Manley, Boston, Mass. (L. R., 448), and reply sent (Letter Book, p. 736).

Letters stating their inability to have guns for the present session of the board, but expecting to be ready for a future session, were received from P. Everitt, London, England (L. R., 489); Knoop, Frerichs & Co., New York (L. R., 490), and John H. Blake, New York (L. R., 491).

A letter was received from George Fogerty, Cambridgeport, Mass. (L. R., 492), desiring to purchase a caliber .30 barrel, and suitable action (Letter Book, pp. 738 and 739) taken thereon.

There being no other guns on hand ready for trial, and none being anticipated for over a month, the board adjourned to meet in New York City on April 5, 1892.

ARMY BUILDING,
New York City, April 5, 1892.

The board met pursuant to adjournment.

Present: All the members.

The recorder laid before the board the communications received since the last adjournment. These included requests to purchase caliber .30 barrels or cartridges from Arthur Savage, Utica, N. Y. (L. R., 496 and 540); John H. Blake, New York City (L. R., 512); J. N. Reece, Springfield, Ill. (L. R., 522), and the Lee Arms Company, Hartford, Conn. (L. R., 528).

With reference to guns they expected to submit, from J. W. Mullins, Fariston, Ky. (L. R., 500, 504, and 515); M. H. Durst, London, England (L. R., 507, 510, and 542); Capt. O. Krag and Capt. R. M. Petersen, Kongsberg, Norway (L. R., 525 and 526); Browning Bros., Ogden, Utah (L. R., 533), and Lee Arms Company, Hartford, Conn. (L. R., 537).

Letters making various inquiries, requesting information, or dummy cartridges from R. M. Catlin, Tuscarora, Nev. (L. R., 493); Pitcher Automatic Repeating Firearms Company, Neillsville, Wis. (L. R., 495); H. A. Lewis, Philadelphia, Pa. (L. R., 497 and 501); Hotchkiss Ordnance Company, Washington, D. C. (L. R., 498 and 527); F. E. Fuller, Taun-

ton, Mass. (L. R., 502); E. S. Dorr, Boston, Mass. (L. R., 503); United States Cartridge Company, Lowell, Mass. (L. R., 505 and 513); Lieut. J. C. Bush, U. S. Army (L. R., 506); J. C. Sturgeon, Erie, Pa. (L. R., 508); F. N. Brown, Newton Center, Mass. (L. R., 509); M. T. Drake, Springfield, Mo. (L. R., 511); Irving Boardman, Elmira, N. Y. (L. R., 514); F. W. Cooke, Sault de Ste. Marie, Mich. (L. R., 521 and 532); George Fogerty, Cambridgeport, Mass. (L. R., 523); J. H. Blake, New York City (L. R., 538), and J. A. Faust, Salt Lake City, Utah (L. R., 539).

From Isidor Freedman, New Haven, Conn. (L. R., 194), requesting return of the Godsal gun.

From the commanding officer Frankford Arsenal, with reference to cartridges (L. R., 517, 531, 536, and 541). From the commanding officer Springfield Armory (L. R., 534), requesting data with reference to the barrels of guns before the board.

From the Chief of Ordnance, U. S. Army (L. R., 499, 516, 519, 520, 524, and 543), with reference to the Roumanian Mannlicher and its ammunition, and to the board's request that the new Russian and Italian magazine rifles be procured for trial.

Also the following letter (L. R., 518) from the Adjutant-General of the Army:

HEADQUARTERS OF THE ARMY,
ADJUTANT-GENERAL'S OFFICE,
Washington, March 11, 1892.

SIR: In reply to your letter of the 24th ultimo, recommending a modification of the instructions contained in General Orders 136, of 1890, governing the action of the Board on Magazine Arms, the major-general commanding the Army directs me to inform you that the Secretary of War, approving the recommendation of the Chief of Ordnance, has modified the instructions contained in General Orders No. 136, November 24, 1890, from this office, requiring that arms submitted must use the Frankford Arsenal experimental cartridge, in so far as to direct that the board consider arms which use cannelured cartridge cases.

Very respectfully,

J. C. KELTON,
Adjutant-General.

Lieut. Col. ROBT. H. HALL,
Sixth Infantry, President Board on Magazine Arms,
National Armory, Springfield, Mass.

The replies and other communications of the recorder were also laid before the board. These included a report (Letter Book, p. 741) to the Chief of Ordnance of the transactions of the board up to February 26, 1892; a circular letter (Letter Book, p. 744) to Mr. Don D. Miles and fifty-two others, informing them of the April session; letters informing certain inventors of the authority to use grooved-headed cartridges (Letter Book, pp. 782 and 783); letters to the Chief of Ordnance with reference to ammunition and arms before the board (Letter Book, pp. 778, 779, 785, and 787), and letters (Letter Book, pp. 748 to 814) in reply to the various inquiries received.

After examination, all this correspondence was approved by the board.

Capt. A. H. Russell, Ordnance Department, appeared before the board and exhibited two guns having magazines of his invention, but not being adapted to the caliber .30 cartridge they were not formally submitted.

A reply (Letter Book, p. 816) was sent to the commanding officer Springfield Armory, acceding to his request for data with reference to the barrels of the guns before the board.

The inventors expected from Europe not having arrived, the board then adjourned to meet at the Springfield Armory on April 8, 1892.

SPRINGFIELD ARMORY,
Springfield, Mass., April 8, 1892.

The board met pursuant to adjournment.

Present: All the members.

Letters were received from J. W. Mullins. Fariston, Ky. (L. R., 546); O. S. Smith, Granby, Vt. (L. R., 547); F. J. Evans, Iowa Falls, Iowa (L. R., 548), and J. H. Blake, New York City (L. R., 545), with reference to guns they were preparing, and replies (Letter Book, pp. 817, 820, and 822) sent.

A letter (L. R., 544) was also received from the Chief of Ordnance with reference to the latest form of Mauser magazine gun.

A letter (Letter Book, p. 819) was sent to Capt. A. H. Russell, Ordnance Department, inclosing, in compliance with his request, sample caliber .30 cartridges.

Some alterations having been made in the Berthier rifle, formerly before the board, it was resubmitted, entered on the docket as Berthier No. 3, and its test prosecuted to include the safety test and a portion of the regular tests, with results as in the synopsis of tests.

The Schmidt gun as adopted by Switzerland was then taken up, the safety test concluded, and the regular test of rapidity with accuracy, rapidity at will, and a portion of the endurance test concluded, with results as in the synopsis. The board then adjourned to meet on the 9th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., April 9, 1892.

The board met pursuant to adjournment.

Present: All the members.

A letter (L. R., 549) was received from the Lee Arms Company stating their gun would not be ready to present to the board at this session, and a letter (L. R., 550) from the United States Cartridge Company, Lowell, Mass., introducing Mr. E. W. Kelly, who brought drawings of a magazine gun before the board, and replies (Letter Book, pp. 823 and 824) sent.

The test of the Schmidt gun was then resumed, the endurance and dust tests and a portion of the test with defective cartridges being concluded, with results as in the synopsis of tests.

The test of the Mannlicher, caliber .256, as adopted by Roumania, was commenced and prosecuted as far as to conclude all the regular tests and all the supplementary tests, to include the first portion of the rust test with results as in the synopsis of tests.

The board then adjourned to meet on Monday, the 11th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., April 11, 1892.

The board met pursuant to adjournment.

Present: All the members.

The Mannlicher (Roumania), which had been subjected to the first portion of the rust test, was examined, but a proper coating not having been deposited, the gun was cleaned and temporarily laid aside.

There being no other arms awaiting trial, and none being expected for some time, the board then adjourned to meet in New York City on May 3, 1892.

ARMY BUILDING,
New York City, May 3, 1892.

The board met pursuant to adjournment.

Present: All the members.

The recorder laid before the board the communications received by him since the last adjournment. These included requests to purchase caliber .30 barrels or cartridges from F. J. Evans, Iowa Falls, Iowa (L. R., 556 and 567); Winchester Arms Company, New Haven, Conn. (L. R., 577 and 581); Allen Webster, Springfield, Mass. (L. R., 583), and Don D. Miles, Aurora, Ill. (L. R., 589).

With reference to guns they expected to submit, from Alfons Mauser, Hartford, Conn. (L. R., 551); J. W. Blake, Dalton, Ga. (L. R., 554 and 584); Capt. O. Krag, Kongsberg, Norway (L. R., 557); J. L. Smith, Brooklyn, N. Y. (L. R., 558); Arthur Savage, Brooklyn, N. Y. (L. R., 560); M. H. Durst, London, England (L. R., 563 and 591); Gen. J. N. Reece, Springfield, Ill. (L. R., 565); Capt. A. H. Russell, U. S. Army (L. R., 570 and 587); Ivert Larsen, Chicago, Ill. (L. R., 579); D. D. Miles, Aurora, Ill. (L. R., 582); John Ford, Portneuf, Canada (L. R., 585); J. H. Acton, Aurora, Ill. (L. R., 586), and the Lee Arms Company, Hartford, Conn. (L. R., 592).

Letters stating they would not have guns at this session, from ten inventors (L. R., 559, 561, 562, 564, 566, 568, 569, 574, 580, and 590). Letters stating they had abandoned the idea of bringing guns before the board, from H. H. Cummings & Co., Boston, Mass. (L. R., 571), and W. G. Gray, Ashland City, Tenn. (L. R., 578).

Letters from the Chief of Ordnance (L. R., 552, 553, 575, and 576) with reference to cartridges with cannelured heads for the tests of the board, and from the commanding officer Frankford Arsenal (L. R., 555, 572, 573, and 588) with reference to the manufacture and shipment of cartridges.

The replies and other communications of the recorder were also laid before the board. These included a report (Letter Book, p. 826) to the Chief of Ordnance of the transactions of the board up to April 12, 1892; also a circular letter (Letter Book, p. 829) to the Lee Arms Company and fifty-six others, informing them of the session to be held in the first week in May; letters to the Chief of Ordnance with reference to arms and ammunition before the board (Letter Book, pp. 836, 837, and 850), and letters (Letter Book, pp. 834 and 867) in reply to the various inquiries received.

After examination, all this correspondence was approved by the board.

Mr. John H. Blake, of New York, appeared before the board and exhibited and explained a model of the gun he had under construction for future test.

The board then adjourned to meet on the 4th instant.

ARMY BUILDING,
New York City, May 4, 1892.

The board met pursuant to adjournment.

Present: All the members.

Lieut. Col. J. P. Farley, commanding Frankford Arsenal (a member of the board), laid before the board various matters relating to the manufacture there of cartridges for the tests of arms submitted. After discussion, the opinions of the board on the subject were embodied in a letter addressed to Colonel Farley (Letter Book, page 868).

The board then adjourned to meet in New York on the 10th instant.

ARMY BUILDING,
New York City, May 10, 1892.

The board met pursuant to adjournment.

Present: All the members.

The recorder laid before the board letters received from George Fogerty, Cambridgeport, Mass. (L. R., 593), desiring to purchase caliber .30 cartridges; J. N. Reece, Springfield, Ill. (L. R., 594), inquiring as to manufacture of reduced caliber Springfield guns; Browning Bros., Ogden, Utah (L. R., 595), stating they had disposed of the guns they had proposed to submit to the board; M. H. Durst, Birmingham, England (L. R., 596), reporting his impending departure with his gun for New York; the Lee Arms Company (L. R., 597), suggesting Tuesday, May 17, for the test of their guns; F. E. Fuller, Taunton, Mass. (L. R., 598), reporting he would not bring a gun before the board; the commanding officer Frankford Arsenal (L. R., 599), with reference to cartridges; Capt. R. M. Petersen, London, England (L. R., 600), reporting his departure from Europe with two guns, and from Alfons Mauser, Hartford, Conn. (L. R., 601), with reference to two guns he was ready to bring before the board.

Various communications from the recorder (Letter Book, pp. 870 to 888) were also laid before the board, including notifications to fifty-four inventors of the trials to begin on the 16th instant, and again advising them of the action of the Secretary of War limiting to June 1, 1892, the period for reception of guns; also answers to various inquiries.

After examination, all this correspondence was approved by the board.

The board then adjourned to meet on the 11th instant.

ARMY BUILDING,
New York City, May 11, 1892.

The board met pursuant to adjournment.

Present: Lieut. Col. Farley, Maj. Freeman, and Capt. Blunt.

Absent: Lieut. Col. Hall, by permission of the board, and Capt. Anderson, in attendance upon a committee of Congress.

Several inventors appeared and submitted inquiries, which were duly answered by the board.

The board then adjourned to meet on the 12th instant.

ARMY BUILDING,
New York City, May 12, 1892.

The board met pursuant to adjournment.

Present: Maj. Freeman and Capt. Blunt.

Absent: Lieut. Cols. Hall and Farley, by permission of the board, and Capt. Anderson, in attendance upon a committee of Congress.

Mr. Durst, not having arrived from Europe, in accordance with his letters, as the board had expected, communications were addressed to him (Letter Book, p. 889) and to the commanding officer Frankford Arsenal (Letter Book, p. 891) with reference to the cartridge shells he was understood to intend to bring over for loading.

The board then adjourned to meet at Springfield Armory on Monday, May 16, 1892.

SPRINGFIELD ARMORY,
Springfield, Mass., May 16, 1892.

The board met pursuant to adjournment.

Present: All the members.

The recorder laid before the board letters stating they would not be able to present guns to the board by June 1, 1892, from R. M. Catlin, Tuscarora, Nev. (L. R., 607); J. C. Sturgeon, Erie, Pa. (L. R., 609); Irving Boardman, Elmira, N. Y. (L. R., 613); James L. White, Pittsburg, Pa. (L. R., 614); C. S. Smith, Granby, Vt. (L. R., 618); S. I. Scott, Washington, D. C. (L. R., 620), and Ivert Larsen, Chicago, Ill. (L. R., 621).

Letters reporting they would bring guns before the board by June 1 or various dates before that, from Thomas B. Wilson, East Boston, Mass. (L. R., 602); Arthur Savage, Brooklyn, N. Y. (L. R., 603); D. D. Miles, Aurora, Ill. (L. R., 606); J. R. Dos Passos, New York City (L. R., 608), and Lee Arms Company, Hartford, Conn. (L. R., 615).

Letters making various inquiries or desiring to purchase calibe: .30 barrels and cartridges, from J. N. Reece, Springfield, Ill. (L. R., 608); Milliken, D'Amour & Co., New York City (L. R., 616), and I. N. Phelps Stokes, New York City (L. R., 622).

Reports from M. H. Durst, Birmingham, England (L. R., 617), that he would sail for New York on May 11, and from Capt. O. Krag, Kongsberg, Norway (L. R., 623), that his representatives would sail from Hamburg on May 5.

Letters from the Chief of Ordnance (L. R., 604) with reference to the Krag-Jörgensen arm, and from the commanding officer Frankford Arsenal (L. R., 610) with reference to caliber .30 cartridges; from the Hotchkiss Ordnance Company, Washington, D. C. (L. R., 605), requesting report of the trial of the Berthier rifle and return of the arm, and from Capt. A. H. Russell, Ordnance Department (L. R., 619), reporting he would present a magazine of his design.

The replies of the recorder to these various communications (Letter Book, pp. 892–904) were also laid before the board.

After examination, all this correspondence was approved by the board.

Letters were received from the Chief of Ordnance (L. R., 624) with reference to the official Danish gun, and from E. B. Riddle, Allegheny City, Pa. (L. R., 625), reporting his gun would not be ready by June 1 and asking if the time would be extended. To the latter a reply (Letter Book, p. 906) was sent.

Telegram (Letter Book, p. 907) was sent to the secretary of the Lee Arms Company, informing him the board was ready to test his gun on the 17th instant.

Mr. Alfons Mauser then brought before the board two modified Mauser guns, which were entered on the records as Mauser Nos. 3 and 4. The test of the former was then begun and continued to include the safety test, the regular tests, and the first portion of the supplementary tests, with results as in the synopsis of tests.

The board then adjourned to meet on the 17th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., May 17, 1892.

The board met pursuant to adjournment.

Present: All the members.

Letters were received from John Ford, Portneuf, Canada (L. R., 626);

F. J. Evans, Iowa Falls, Iowa (L. R., 627), and J. W. Mullins, Fariston, Ky. (L. R., 628), reporting they would have guns by June 1, and a letter (L. R., 629) from the commanding officer Frankford Arsenal with reference to cartridges.

Communications were sent to Thomas B. Wilson, East Boston, Mass. (Letter Book, p. 916); John Ford, Portneuf, Canada (Letter Book, p. 909); J. W. Mullins, Fariston, Ky. (Letter Book, p. 911), and F. J. Evans, Iowa Falls, Iowa (Letter Book, p. 913), in reply to their inquiries.

Mr. J. P. Lee and Mr. E. G. Westcott, president and secretary of the Lee Arms Company, then brought two of their guns before the board; the test of the first, entered on the records as Lee No. 1, was commenced, the safety test and a portion of the regular tests being completed, when the gun was withdrawn by Mr. Lee. The test of the Lee No. 2 was then taken up, the safety test and the regular tests, as far as to include the dust test, being completed, with results as in the synopsis of tests, when the gun was withdrawn by Mr. Lee.

Capt. R. M. Petersen, Royal Norwegian Navy (retired), and Mr. E. Jörgensen, representing the Krag-Jörgensen magazine arms, then brought two of their guns before the board, which were entered on the records as Krag-Jörgensens Nos. 5 and 6.

Letters were sent to the commanding officer Frankford Arsenal (Letter Book, p. 918) with reference to loading cartridges for one of the Krag-Jörgensen guns, and to the Chief of Ordnance (Letter Book, p. 919) requesting a further supply of caliber .30 cartridges.

The board then adjourned to meet on the 18th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., May 18, 1892.

The board met pursuant to adjournment.

Present: All the members.

A letter was received from the United States Cartridge Company, Lowell, Mass. (L. R., 630), making suggestions with reference to cartridges, and one from J. H. Acton, Aurora, Ill. (L. R., 631), with reference to the gun he proposed to submit.

Telegram was sent to Alfons Mauser, Hartford, Conn. (Letter Book, p. 920), informing him his second gun would be tested on the 19th instant.

The test of the Krag-Jörgensen No. 5 was then commenced and continued to include the safety test, the regular tests, and the supplementary tests as far as the rust test, with results as in the synopsis of tests.

The Roumanian gun (Mannlicher) having been two days previously subjected to the preliminary portion of the rust test, was subjected to the second portion, with results as in the synopsis of tests.

The board then adjourned to the 19th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., May 19, 1892.

The board met pursuant to adjournment.

Present: All the members.

Letters were received from F. J. Evans, Iowa Falls, Iowa (L. R., 633), reporting he would not have a gun by June 1; from the Colt's Firearms

Company, Hartford, Conn. (L. R., 634), and the Lee Arms Company, Hartford, Conn. (L. R., 636), requesting caliber .30 cartridges; from the commanding officer Frankford Arsenal (L. R., 632), with reference to cartridges, and from M. H. Durst, New York City (L. R., 635), asking when he could submit his gun to the board.

Replies (Letter Book, pp. 923 to 928) were sent to these communications.

The board then proceeded to the test of the Mauser gun No. 4, the safety test and the regular tests, to include the dust test and a portion of the test with defective cartridges, being concluded, with results as in the synopsis of tests.

There being no other guns on hand awaiting trial, and none being expected immediately, the board adjourned to meet at the Army Building, New York, on May 31, 1892.

ARMY BUILDING,
New York City, May 31, 1892.

The board met pursuant to adjournment.

Present: All the members.

The recorder laid before the board the communications received by him since the last adjournment. These included letters from M. H. Durst, New York City (L. R., 638 and 655), with reference to loading cartridges for his gun; Capt. R. M. Petersen, Hartford, Conn. (L. R., 641, 647, and 659), with reference to the Krag-Jörgensen gun; applications from I. N. Phelps Stokes, New York City (L. R., 640), and F. J. Evans, Iowa Falls, Iowa (L. R., 653), to purchase caliber .30 barrels; applications from Alfons Mauser, Hartford, Conn. (L. R., 644); Knoop, Frerichs & Co., New York City (L. R., 648 and 671); Milliken, D'Amour & Co., New York City (L. R., 667); F. J. Evans, Iowa Falls, Iowa (L. R., 670); I. N. Phelps Stokes, New York City (L. R., 668), and J. H. Acton, Aurora, Ill. (L. R., 669), for extension of time to submit guns. Application from Capt. A. H. Russell, Ordnance Department (L. R., 639), for permission to submit a magazine of his invention attached to the Lee-Speed gun. Inquiries as to whether guns should be presented to the board in New York or in Springfield, from E. H. Risley, Utica, N. Y. (L. R., 643), and Arthur Savage, New York City (L. R., 654). Reports that guns would not be ready by June 1, from J. C. Fitzgerald, Pittsburg, Pa. (L. R., 642); John W. Blake, Dalton, Ga. (L. R., 646); W. A. Hill, Waltham, Mass. (L. R., 657), and J. W. Mullins, Fariston, Ky. (L. R., 664). Reports that guns would be ready by June 1 from E. H. Risley, Utica, N. Y. (L. R., 656); George Fogerty, Cambridgeport, Mass. (L. R., 660), and Ivert Larsen, Chicago, Ill. (L. R., 663.) Letters from the commanding officer Frankford Arsenal, with reference to cartridges (L. R., 649 and 651). Letters making various inquiries from J. N. Reece, Springfield, Ill. (L. R., 645); Milliken, D'Amour & Co., New York City (L. R., 652); H. Glentworth, New York City (L. R., 658); Joseph Reed, Denver, Col. (L. R., 650 and 661); Ensign H. H. Eames, U. S. Navy (L. R., 662); P. Everitt, London, England (L. R., 665), and also the following letter (L. R., 666) from the Secretary of War:

WAR DEPARTMENT,
Washington, D. C., May 26, 1892.

SIR: Referring to instructions dated January 25, 1892, directing that the Board of Magazine Arms should not receive arms for trial after June 1, 1892, but should then

complete its labors and forward its report as soon as practicable, I have to state that, in view of several applications which have been received for extensions in specified cases and also in view of the fact that it is not deemed expedient or fair to grant special extensions to individuals, which might give other inventors cause for complaint, the time for receiving arms for trial is hereby extended to July 1, 1892, and all inventors should be positively informed that no further extensions will be granted and that no new arms will be received after that date. The board will then complete its labors and make its report as soon as possible, and it is hoped and expected that the board will make its report not later than August 20, 1892.

If, however, arms which were presented to the board prior to July 1, 1892, have been taken away by inventors for minor repairs should be again presented to the board after July 1, 1892, it is desired that the board should give such arms any further tests and consideration desirable, provided these further tests will not unduly delay the board's final report.

Respectfully,

S. B. ELKINS,
Secretary of War.

The PRESIDENT OF THE BOARD ON MAGAZINE ARMS,
Army Building, New York City, N. Y.

The replies and other communications of the recorder (Letter Book, pp. 929 to 979) were also laid before the board. These included a report (Letter Book, p. 932) to the Chief of Ordnance of the transactions of the board up to May 20, 1892, and a circular letter (Letter Book, p. 974) addressed to fifty-five inventors, advising them of the extension until July 1 of the period for submitting guns.

After examination, all this correspondence was approved by the board.

Telegrams were received from John Ford, Portneuf, Canada (L. R., 672), stating he would present his gun in person on June 1, and from Capt. A. H. Russell, Ordnance Department, U. S. Army (L. R., 673), inquiring if the time for receiving guns had been extended. A letter was received from Col. L. L. Langdon, U. S. Army (L. R., 674), transmitting the gun of Maj. Horatio Glentworth, of New York, N. Y.

To the above suitable replies (Letter Book, pp. 980 and 981) were sent.

Mr. M. H. Durst appeared before the board and exhibited his gun, submitting also a letter (L. R., 675) descriptive of its features.

Mr. John H. Blake, of New York, N. Y., appeared before the board and arranged for the trial of his gun on the 6th proximo.

It was resolved by the board to hold sessions on June 1, both in New York and Springfield, a portion of the members to be for that purpose present in each place.

The board then adjourned to meet on June 1, 1892.

SPRINGFIELD ARMORY,
Springfield, Mass., June 1, 1892.

The board met pursuant to adjournment.

Present at Springfield Armory, Lieut. Cols. Hall and Farley, and Capt. Blunt; at the Army Building, New York, Maj. Freeman and Capt. Anderson.

A telegram was received from the commanding officer Frankford Arsenal (L. R. 676), with reference to cartridges for the Durst gun, and reply (Letter Book, p. 988) sent. Letters were received from Lewis Altmaier, Philadelphia, Pa. (L. R., 677), and the Colt's Arms Factory, Hartford, Conn. (L. R., 678), desiring to purchase caliber .30 cartridges. Letters were received from Allen Webster, Springfield, Mass. (L. R., 679), and Edwin H. Risley, Utica, N. Y. (L. R., 680), with reference to dates for the trial of the Wilson and Savage guns.

Mr. Wilson and Mr. Arthur Savage also appeared in person before the board and conferred with reference to these dates.

Guns were submitted in person by John Ford, Portneuf, Canada, Ivert Larsen, Chicago, Ill., and Don D. Miles, Aurora, Ill., and dates assigned for their test.

A telegram (Letter Book, p. 987) was sent to M. H. Durst, New York, assigning a date for the trial of his gun.

The board then adjourned to meet at Springfield Armory on June 2.

SPRINGFIELD ARMORY,
Springfield, Mass., June 2, 1892.

The board met pursuant to adjournment.

Present: All the members.

Telegrams were received from the commanding officer Frankford Arsenal (L. R., 681), with reference to cartridges, and from Don D. Miles, Aurora, Ill. (L. R., 683), with reference to his gun.

Letters were received from the Chief of Ordnance (L. R., 684) with reference to the gun of J. W. Blake, Dalton, Ga.; from Capt. A. H. Russell, Ordnance Department, U. S. Army (L. R., 685), with reference to his gun; from C. S. Smith, Granby, Vt. (L. R., 686), stating his gun would not be ready for the board; from the commanding officer Frankford Arsenal (L. R., 687) and the United States Cartridge Company, Lowell, Mass. (L. R., 688), with reference to cartridges; and from Capt. G. S. L. Ward, U. S. Army (retired), with reference to a magazine arm invented by Gen. Davis. Letters (Letter Book, pp. 982 to 992) in reply to these communications were sent.

The test of the Krag-Jörgensen No. 6 was then commenced in the presence of Capt. R. M. Petersen, royal Norwegian navy (retired), and Mr. E. Jörgensen, representing the gun, the safety tests, all of the regular tests, and the supplementary tests as far as the rust test being concluded, with results as in the synopsis of tests.

The Krag-Jörgensen No. 5 was also submitted to the preliminary portion of the rust test.

The board then adjourned to meet on the 3d instant.

SPRINGFIELD ARMORY,
Springfield, Mass., June 3, 1892.

The board met pursuant to adjournment.

Present: All the members.

Letters were received from the commanding officer Frankford Arsenal (L. R., 690 and 692), with reference to cartridges, and from M. H. Durst, New York (L. R., 691 and 693), with reference to the trial of his gun, to which replies (Letter Book, pp. 993 to 995) were sent.

The test of the Ford gun was commenced in the presence of the inventor, Mr. John Ford, of Portneuf, Canada, a portion of the safety test being given, with results as in the synopsis of tests, when the gun was withdrawn by the inventor for alteration.

The test of the Russian magazine gun, model 1891, was then commenced, the safety test and the regular tests as far as to include a portion of the test for defective cartridges being concluded, with results as in the synopsis of tests.

The board then adjourned to meet on the 4th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., June 4, 1892.

The board met pursuant to adjournment.

Present: All the members.

A letter was received from the Chief of Ordnance (L. R., 694) with reference to the Russian magazine rifle, and reply (Letter Book, p. 996) sent.

Telegrams were received from M. H. Durst, New York City (L. R., 698), and J. H. Blake, Brooklyn, N. Y. (L. R., 697), with reference to dates for test of their guns.

Letters were received from the Pitcher Arms Company, Neillsville, Wis. (L. R., 695), and from Joseph L. Reed, Denver, Colo. (L. R., 696), relating to their guns, and replies (Letter Book, pp. 997 to 1000) sent.

A letter (Letter Book, p. 1001) was sent to Maj. Glentworth, New York City, informing him his gun would be tested on June 8.

The board then took up a modified Springfield rifle, with quick-loading attachment, submitted through the Chief of Ordnance by Brig. Gen. J. C. Kelton, Adjutant-General U. S. Army, the safety test and a portion of the first test for rapidity with accuracy being concluded, with results as in the synopsis of tests.

The test of the Hampden magazine gun, presented by Mr. Allen Webster and Mr. Thomas B. Wilson, of Springfield; Mass., was then commenced, the safety test being concluded and the regular tests as far as to include a portion of that for rapidity at will, with results as in the synopsis of tests.

The gun was then withdrawn by the inventor for certain repairs and corrections.

The Krag-Jörgensen No. 5, which had been subjected to the preliminary portion of the rust test on the 2d instant, was examined, and the test concluded, with results as in the synopsis.

The Krag-Jörgensen No. 6 was subjected to the preliminary portion of the rust test.

The board then adjourned to meet on Monday, the 6th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., June 6, 1892.

The board met pursuant to adjournment.

Present: All the members.

Telegrams were received from John H. Blake, Brooklyn, N. Y. (L. R., 699 and 706), and M. H. Durst, New York City (L. R., 700 and 701), with reference to the dates for the trial of their guns, and letters from the commanding officer Frankford Arsenal (L. R., 702 and 704), with reference to cartridges; from J. W. Mullins, Fariston, Ky. (L. R., 703), reporting he would have his gun by July 1, and from Arthur Savage, Brooklyn, N. Y. (L. R., 705), reporting he would not have his gun ready for this session of the board.

Replies (Letter Book, pp. 1002 to 1008) to these communications were sent.

The board then commenced the test of the Durst gun in the presence of the inventor, Mr. M. H. Durst, of Wheatlands, Cal., the safety test and the first portion of the test for rapidity with accuracy being completed, with results as in the synopsis of tests.

The gun was then withdrawn by the inventor for alteration.

The test of the Larsen gun was begun in the presence of the inventor, Mr. Ivert Larsen, of Chicago, Ill., the safety test and the regular tests to include a portion of that for defective cartridges being concluded, with results as in the synopsis.

The test of the Kelton gun was also conducted to include the first portion of the regular tests, with results as in the synopsis of tests.

The board then adjourned to meet on the 7th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., June 7, 1892.

The board met pursuant to adjournment.

Present: All the members.

Mr. Don D. Miles, of Aurora, Ill., presented his magazine gun to the board; it was given the safety test and the first portion of the regular tests, with results as in the synopsis of tests.

Mr. Miles then withdrew the gun for alteration.

A letter was received from the commanding officer Frankford Arsenal (L. R., 707) with reference to cartridges.

A telegram (Letter Book, p. 1009) was sent to Maj. Glentworth, New York, informing him the test of his gun would be postponed until July, a sufficient number of cartridges not yet being ready.

There being no other guns awaiting trial, and none being expected, the board adjourned to meet in New York City on June 14, 1892.

ARMY BUILDING,
New York City, June 14, 1892.

The board met pursuant to adjournment.

Present: Lieut. Col. Farley, Maj. Freeman, and Capt. Blunt.

Absent: Lieut. Col. Hall and Capt. Anderson, the former by permission of the board, and the latter at Fort Yellowstone, Wyo., in compliance with paragraph 6, Special Orders 137, Headquarters of the Army, of June 11, 1892.

The recorder laid before the board the correspondence since the last adjournment. This included letters received from Capt. R. M. Petersen (L. R., 708, 709, 714, and 717), with reference to the Krag-Jörgensen guns, and desiring copy of the report of their test; from M. H. Durst, New York (L. R., 710), stating he proposed to submit a new gun; from C. D. Weldon, Mica, Wash. (L. R., 711), and J. H. Acton, Aurora, Ill. (L. R., 716), reporting they would not be able to submit guns to the board; from John Ford, Portneuf, Canada (L. R., 712), desiring to purchase caliber .30 cartridges; from Arthur Savage, Brooklyn, N. Y. (L. R., 713), and Edwin H. Risley, Utica, N. Y. (L. R., 715), reporting the Savage gun was ready for trial, and with reference to the cartridges adapted to it.

The letters sent by the recorder (Letter Book, pp. 1010 to 1027), including a report to the Chief of Ordnance of the transactions of the board up to June 7, and the replies to the various inquiries received, were also submitted.

After examination, all this correspondence was approved by the board.

Mr. Arthur Savage, of Brooklyn, N. Y., appeared before the board, submitting his magazine arm and explaining its manipulation and construction.

Mr. John H. Blake, New York City, also appeared and discussed matters in connection with the gun he intended to submit.

The board then adjourned to meet at the Army Building, New York City, on June 30, 1892.

ARMY BUILDING,
New York City, June 30, 1892.

The board met pursuant to adjournment.

Present: Lieut. Col. Farley, Maj. Freeman, and Capt. Blunt.

Absent: Lieut. Col. Hall and Capt. Anderson, the former by permission of the board and the latter at Fort Yellowstone, Wyo., in compliance with paragraph 6, Special Orders 137, Headquarters of the Army, of June 11, 1892.

The recorder laid before the board the correspondence since the last adjournment. This included letters received from the Colt's Arms Company, Hartford, Conn. (L. R., 718), and I. N. Phelps Stokes, New York City (L. R., 727), desiring to purchase caliber .30 barrels and cartridges; from J. H. Acton, Aurora, Ill. (L. R., 723), reporting he would not have a gun to present to the board.

With reference to their guns, from James L. Smith, Brooklyn, N. Y. (L. R., 720); P. Everitt, London, England (L. R., 725); Don D. Miles, Aurora, Ill. (L. R., 726 and 731), and John Ford, Portneuf, Canada (L. R., 729).

Explaining the features of their rifles and submitting them to the board, from Arthur Savage, Brooklyn, N. Y. (L. R., 721, 732, and 740); John W. Blake, New York City (L. R., 737 and 743), and J. W. Mullins, Fariston, Ky. (L. R. 744).

From J. P. Lee, Hartford, Conn. (L. R., 722), desiring to submit a model of breech action of his invention.

Letters making various inquiries or requests from Capt. R. W. Schufeldt, U. S. Army (L. R., 728); L. P. Dixon, Toledo, Ohio (L. R., 734); F. E. Fuller, Taunton, Mass. (L. R., 736); Alfons Mauser, Hartford, Conn. (L. R., 738); Lee Arms Company, South Windham, Conn. (L. R., 739); James McIntire, South Boston, Mass. (L. R., 741), and Edwin H. Risley, Utica, N. Y. (L. R., 742). From the Chief of Ordnance, authorizing the employment of clerk, draftsman, etc., after July 1, 1892 (L. R., 733), and also the following letter (L. R., 735) from the Chief of Ordnance and the Secretary of War:

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, June 17, 1892.

SIR: I have the honor to recommend that the board convened by General Orders No. 136 of 1890, to consider and recommend a suitable magazine system for rifles and carbines for the military service, may be instructed to give their opinion as to the relative merits of a magazine arm and a single loader for use in the United States service based upon experience gained.

I would recommend further that in case the board does not, as a board, agree upon the subject that the individual members be directed to submit their several opinions thereon.

It is deemed desirable that the board should give their opinions as based upon their knowledge of the subject gained during the performance of the duties that have been assigned them.

This course will facilitate a conclusion in the matter and the opinions of the officers who have given a long time to the consideration of magazine arms and have great experience relating to details will thus be made available.

Very respectfully,

D. W. FLAGLER,
Brig. Gen., Chief of Ordnance.

The SECRETARY OF WAR.

[First indorsement.]

WAR DEPARTMENT, *June 23, 1892.*

Respectfully referred to the Board on Magazine Arms, approved.

S. B. ELKINS,
Secretary of War.

The replies of the recorder (Letter Book, pp. 1028 to 1056) to these various communications were also submitted, and, after examination, approved by the board.

Mr. James L. Smith of Brooklyn, N. Y., then appeared before the board and submitted his magazine gun, a date for the trial of which was duly assigned.

The board then adjourned to meet on July 1.

ARMY BUILDING,
New York City, July 1, 1892.

The board met pursuant to adjournment.

Present: Maj. Freeman and Capt. Blunt, the latter being later in the day also at Springfield Armory to receive guns that might be there submitted.

Absent: Lieut. Col. Hall, by permission of the board; Lieut. Col. Farley, detained at Frankford Arsenal by official business, and Capt. Anderson at Fort Yellowstone, Wyo., in compliance with paragraph 6, Special Orders 137, Headquarters of the Army, of June 11, 1892.

Letters and telegrams were received in New York and Springfield with reference to their guns, or submitting the same, from M. H. Durst, Hartford, Conn. (L. R., 745, 752, and 755); Lee Arms Company, Hartford, Conn. (L. R., 747); J. W. Mullins, Fariston, Ky. (L. R., 748); Capt. A. H. Russell, U. S. Army (L. R., 756); John W. Blake, New York City (L. R., 757), and J. G. Accles, Birmingham, England (L. R., 759).

Letters reporting their guns were not ready for test and making various inquiries, from F. J. Evans, Iowa Falls, Iowa (L. R., 749); L. P. Dixon, Toledo, Ohio (L. R., 750); Alfonso Mercer, Norfolk, Va. (L. R., 751); Knoop, Frerichs & Co., New York City (L. R. 754), and James McIntire, South Boston, Mass. (L. R., 758).

From the commanding officer Frankford Arsenal with reference to cartridges for the board (L. R., 746), and from Don D. Miles, Aurora, Ill. (L. R., 758), desiring to purchase caliber .30 cartridges.

Letters were sent (Letter Book, pp. 1057 to 1065) in reply to these communications.

Magazine arms were presented to the board by the Chaffee-Reece Arms Company, Washington, D. C.; Capt. A. H. Russell, Ordnance Department, U. S. Army, and George Fogerty, Cambridgeport, Mass.

The board then adjourned to meet at the Springfield Armory, Springfield, Mass., on July 7, 1892.

SPRINGFIELD ARMORY,
Springfield, Mass., July 7, 1892.

The board met pursuant to adjournment.

Present: All the members.

The recorder laid before the board the correspondence since the last adjournment. This comprised letters with reference to their guns or the

dates for their trial, from Capt. A. H. Russell, U. S. Army (L. R., 761); Don D. Miles, Aurora, Ill. (L. R., 762); John H. Blake, New York City (L. R., 765); Arthur Savage, Brooklyn, N. Y. (L. R., 766), and George Fogerty, Cambridgeport, Mass. (L. R., 767).

From the Chief of Ordnance, U. S. Army (L. R., 763), with reference to the Schmidt gun; from Browning Bros., Ogden, Utah (L. R., 764), inquiring if they could submit a rifle during July, and from the commanding officer Frankford Arsenal (L. R., 768), with reference to cartridges.

The recorder's replies to these communications (Letter Book, pp. 1066 to 1068) were also submitted.

After examination, all this correspondence was approved by the board.

Mr. Arthur Savage, of Brooklyn, N. Y., then appeared before the board to witness the test of his gun, which was conducted to include the safety test and a portion of the regular tests, with results as in the synopsis of tests. The gun was then withdrawn by Mr. Savage for repairs.

The gun of Mr. J. W. Mullins, of Fariston, Ky., was then taken up, and the safety test and a portion of the regular tests concluded, with results as in the synopsis of tests.

The board then adjourned to meet on the 8th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., July 8, 1892.

The board met pursuant to adjournment.

Present: All the members.

Letters were received from Arthur Savage, Brooklyn, N. Y. (L. R., 769), and the Lee Arms Company, Hartford, Conn. (L. R., 770), with reference to dates for the trial of their guns. Replies were sent to them, and also letters to George Fogerty, Cambridgeport, Mass., Capt. A. H. Russell, U. S. Army, and Allen Webster, Springfield, Mass. (Letter Book, pp. 1069 to 1073), assigning days when the board would test their guns.

The Chaffee-Reece gun was then taken up, and the test conducted as far as to include a portion of that for endurance, with results as in the synopsis of tests.

The board then adjourned to meet on the 9th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., July 9, 1892.

The board met pursuant to adjournment.

Present: All the members.

A letter (L. R., 771) was received from J. W. Mullins, Fariston, Ky., with reference to his gun, and reply (Letter Book, p. 1074) sent.

Letters were also received from Capt. A. H. Russell, U. S. Army (L. R., 773), with reference to the date for the examination of his guns, and from the Chief of Ordnance (L. R., 772 and 774) with reference to the use of the Krag-Jörgensen gun in Denmark, and advising the board of the decision to adhere to July 1, 1892, as the final date for the reception of guns.

The test of the Blake gun was then begun in the presence of the inventor, Mr. John H. Blake, of New York, N. Y., and continued to include the test for rapidity at will, when the gun was withdrawn for some alterations, to be again presented on the 19th instant.

The board then adjourned to meet on Monday, July 11.

SPRINGFIELD ARMORY,
Springfield, Mass., July 11, 1892.

The board met pursuant to adjournment.

Present: Lieut. Cols. Hall and Farley, Maj. Freeman, and Capt. Anderson.

Absent: Capt. Blunt, on leave of absence, per Orders No. 30, Springfield Armory, July 11, 1892.

Mr. Alfons Mauser appeared before the board and stated that the last model of his gun was on hand ready for submission, but that the cartridges for the test had not yet been received from Europe, though they were soon expected.

Mr. James L. Smith, of Brooklyn, N. Y., who had made engagement with the board to bring his gun for trial, not appearing, the board then adjourned to the 12th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., July 12, 1892.

The board met pursuant to adjournment.

Present: Lieut. Cols. Hall and Farley, Maj. Freeman, and Capt. Anderson.

Absent: Capt. Blunt, on leave of absence, per Orders No. 30, Springfield Armory, July 11, 1892.

Letters were received from Capt. A. H. Russell, U. S. Army (L. R., 776), and J. W. Blake, Dalton, Ga. (L. R., 777), with reference to their guns, and from George Fogerty, Cambridgeport, Mass. (L. R., 775), stating he would prefer the 19th or 20th instant to the 15th, as assigned him, for test of his gun, and reply granting his request (Letter Book, p. 1075) sent.

Mr. J. P. Lee brought one of his guns before the board for retest, and its trial was then conducted to include all of the regular tests and a portion of the first supplementary test, with results as in the synopsis of tests, Lee No. 3.

The board then adjourned to meet on the 13th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., July 13, 1892.

The board met pursuant to adjournment.

Present: Lieut. Cols. Hall and Farley, Maj. Freeman, and Capt. Anderson.

Absent: Capt. Blunt, on leave of absence, per Orders No. 30, Springfield Armory, July 11, 1892.

Letters were received from the following: From W. J. Bly, Florence, Ariz. (L. R., 778), making various inquiries with reference to magazine guns; from Capt. A. H. Russell, U. S. Army (L. R., 779), reporting shipment of cartridges for test of his guns; from Alfons Mauser, New York City (L. R., 781), stating it would be two weeks before the ammunition for his gun could arrive from Europe, and from M. H. Durst, Hartford, Conn. (L. R., 780), asking whether his gun had yet arrived in New York from England. To the latter reply (Letter Book, p. 1076) was sent.

The Hampden gun No. 2 was then brought before the board, and in the presence of Mr. T. B. Wilson, of Springfield, Mass., its inventor, its test conducted to include all of the safety and regular tests and the supplementary tests up to the rust test, with results as in the synopsis of tests.

The board then adjourned to the 14th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., July 14, 1892.

The board met pursuant to adjournment.

Present: Lieut. Cols. Hall and Farley, Maj. Freeman, and Capt. Anderson.

Absent: Capt. Blunt, on leave of absence, per Orders No. 30, Springfield Armory, July 11, 1892.

Letters were received from the Lee Arms Company (L. R., 782 and 784) with reference to their guns, and from Alfons Mauser, New York City (L. R., 783), reporting his cartridges would not arrive from Europe for fifteen days.

Maj. W. R. Livermore, Corps of Engineers, U. S. Army, and Capt. A. H. Russell, Ordnance Department, U. S. Army, then brought before the board two Lee-Speed guns, so modified as to embody their magazine inventions.

The test of the first of these guns was conducted to include the safety test, when it was withdrawn for certain modifications.

The test of the second was conducted to include the safety test and the regular tests up to that for endurance, with results as in the synopsis of tests, when this gun was also withdrawn for correction.

The test of the Lee No. 3 was then resumed with the fifth of the regular tests, the regular tests concluded and the supplementary tests conducted up to the rust test, with results as in the synopsis.

The Hampden gun No. 2 was subjected to the preliminary portion of the rust test.

The board then adjourned to the 16th instant, there being no guns ready for trial on July 15.

SPRINGFIELD ARMORY,
Springfield, Mass., July 16, 1892.

The board met pursuant to adjournment.

Present: Lieut. Cols. Hall and Farley, Maj. Freeman, and Capt. Anderson.

Absent: Capt. Blunt, on leave of absence, per Orders No. 30, Springfield Armory, July 11, 1892.

Letters were received from J. G. Accles, Birmingham, England (L. R., 786), with reference to the Durst gun; from Knoop, Frerichs & Co., New York, N. Y. (L. R., 787), requesting return of certain drawings and descriptions they had previously submitted; from the Chief of Ordnance, U. S. Army (L. R., 788), referring a letter of the commanding officer Springfield Armory with reference to a caliber .30 Springfield single-loader, and from M. H. Durst, Hartford, Conn. (L. R., 785), with reference to obtaining his gun from the custom-house in New York. To the latter a reply (Letter Book, p. 1077) was sent.

The test of the first Russell-Livermore gun was resumed and conducted to include all of the regular tests, with results as in the synopsis.

The test of the second Russell-Livermore gun was resumed with that for endurance, which was concluded, with results as in the synopsis. The Lee gun No. 3 was subjected to the preliminary portion of the rust test.

The board then adjourned to meet on Monday, the 18th instant,

SPRINGFIELD ARMORY,
Springfield, Mass., July 18, 1892.

The board met pursuant to adjournment.

Present: All the members.

Letters were received from J. W. Mullins, Fariston, Ky. (L. R., 789 and 790), and M. H. Durst, Hartford, Conn. (L. R., 791 and 792), with reference to their guns; from W. H. Wiley, New York City (L. R., 793), making inquiries as to the Durst gun; from Gen. J. N. Reece, Springfield, Ill. (L. R., 794), with reference to a modification of the Springfield gun, and from Riley Bowers, Springfield, Ill. (L. R., 795), with reference to his machine gun. To these last three replies (Letter Book, pp. 1079, 1083, and 1089) were sent.

Letters (Letter Book, pp. 1082 and 1087) were also sent to W. J. Bly, Florence, Ariz., and Knoop, Frerichs & Co, New York City, in reply to their communications received some days previously, and telegram (Letter Book, p. 1078) to the commanding officer Frankford Arsenal, and letter to Alfons Mauser, Hartford, Conn. (Letter Book, p. 1085), suggesting July 20 for the trial of his gun.

Mr. Arthur Savage, of Brooklyn, N. Y., then submitted his gun to the board, and its test was conducted to include the safety test and all of the regular tests, with results as in the synopsis of tests, Savage No. 2. The second portion of the rust test of the Lee gun No. 3 was completed, with results as in the synopsis.

The dust test of the Russell-Livermore gun No. 2 was completed, witb results as in the synopsis.

The board then adjourned to the 19th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., July 19, 1892.

The board met pursuant to adjournment.

Present: All the members.

A telegram was received from J. H. Blake, Brooklyn, N. Y. (L. R., 796), reporting he would not be able to present his gun this day, as had been agreed upon, and reply (Letter Book, p. 1091) sent.

A telegram was also received from Mr. J. P. Lee (L. R., 797), stating he would present to the board at 1 p. m. an improvement upon the last Lee arm.

Mr. Alfons Mauser presented to the board a Mauser gun embodying some corrections suggested by the trial of the last gun. Its trial was postponed pending the receipt of appropriate cartridges.

The board then proceeded to examine and discuss the record of trials of arms, until Mr. Lee appeared and presented his modifications in the form of a wooden model, which was duly considered.

The Russell-Livermore guns Nos. 1 and 2 were then taken up and a portion of the defective cartridge test conducted with results as in the synopsis of tests.

The board then adjourned to the 20th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., July 20, 1892.

The board met pursuant to adjournment.

Present: All the members.

Letters were received from M. H. Durst, Hartford, Conn. (L. R., 798

and 799), with reference to his gun now awaiting trial and telegraphic reply (Letter Book, p. 1093) sent. Letters were also received from George Fogerty, Cambridgeport, Mass. (L. R., 800), and Capt. A. H. Russell, U. S. Army (L. R. 801), with reference to their guns, and from William H. Wiley, New York City (L. R., 802), in reply to one previously sent by the recorder.

A telegram (Letter Book, p. 1094) was sent to the commanding officer Frankford Arsenal with reference to cartridges for the Mauser gun.

Mr. George Fogerty then brought his gun before the board, but it not being quite ready for trial its test was postponed to the following day.

Mr. Alfons Mauser presented the latest model of Mauser gun, which was entered on the record as Mauser No. 5, and the 22d instant assigned for its test.

The board then adjourned to July 21.

SPRINGFIELD ARMORY,
Springfield, Mass., July 21, 1892.

The board met pursuant to adjournment.

Present: All the members.

Letters were received from M. H. Durst, Hartford, Conn. (L. R., 803), and John H. Blake, New York City (L. R., 804), with reference to their guns, and from the commanding officer Frankford Arsenal (L. R., 805) with reference to cartridges with cannelured heads made there. The test of the Fogerty gun was then commenced in the presence of the inventor, Mr. George Fogerty, Cambridgeport, Mass., the safety test and the first portion of the regular test being completed, with results as in the synopsis of tests.

The test of the Durst gun No. 2 was begun in the presence of the inventor, Mr. M. H. Durst, the safety test and the first portion of the regular tests being conducted with results as in the synopsis of tests.

The board then adjourned to the 22d instant.

SPRINGFIELD ARMORY,
Springfield, Mass., July 22, 1892.

The board met pursuant to adjournment.

Present: All the members.

Letters were received from M. H. Durst, Hartford, Conn. (L. R., 806 and 807), and a reply (Letter Book, p. 1095) sent.

Lieut. Col. Farley made to the board the following remarks, which he desired to have entered on the record:

In furnishing the lot of 500 headless or so-called cannelured cartridges for the board, manufactured at the Frankford Arsenal for the Belgian Mauser magazine gun, and made after the sample cartridge sent me by the board through its recorder, I find that in spite of every effort to conform to the dimensions of the sample that a portion of the cartridges (as is represented to me by Capt. Blunt) have fallen a little short in point of dimensions. It is found that these cartridges, which are short in this respect, are the ones which, having been selected out from the lot by Capt. Blunt, are the only ones suitable for the rapid fire test of the new Mauser gun this day to undergo trial at the water shops under the rules of the board. It is also found (as represented by Capt. Blunt) that the Mauser cartridges proper, some 100 or more of which remain at the armory, the lot from which the sample was furnished me, will not enter, unless strongly forced, the chamber of the new Mauser rifle. This clearly indicates that, except for the unfortunate variation of dimensions in the

Mauser cartridge as manufactured at the Frankford Arsenal, the board would have been unable to use any of the lot of 500 now furnished, as they would in such case have disparaged the performance of the gun in the rapidity test.

These facts are now brought to the attention of the board as throwing light upon the possible difficulties to be encountered in affording a magazine gun a fair trial in service with the headless cartridge.

The trial of the Mauser No. 5 was then commenced in the presence of Mr. Alfons Mauser, and the safety test and so much of the regular tests as the supply of ammunition then on hand would permit completed, with results as in the synopsis of tests.

The board then adjourned to the 23d instant.

SPRINGFIELD ARMORY,
Springfield, Mass., July 23, 1892.

The board met pursuant to adjournment.

Present: Lieut. Cols. Hall and Farley and Capt. Blunt.

Absent: Maj. Freeman and Capt. Anderson, by permission of the board.

The additional ammunition for the Mauser No. 5 having been received from Frankford Arsenal, telegram (Letter Book, p. 1097) was sent Mr. Alfons Mauser informing him that the defective cartridge test of the gun would be given on Monday, the 25th.

The trial of the Blake No. 2 was then begun, a portion of the rapidity test being conducted with results as in the synopsis of tests.

The test of the Rubin gun was partly conducted with results as in the synopsis.

The Schüllhof gun was examined by the board but not fired, there being no ammunition available for the purpose. These last two guns had previously been tested by boards of ordnance officers and the results published in the Report of the Chief of Ordnance for 1889; the records then made were examined by the board.

The trial of the Mauser No. 5 was then resumed, the endurance and dust tests being completed, with results as in the synopsis of tests.

The board then adjourned to meet on Monday, July 25.

SPRINGFIELD ARMORY,
Springfield, Mass., July 25, 1892.

The board met pursuant to adjournment.

Present: All the members.

Letters were received from the commanding officer Springfield Armory (L. R., 809) with reference to a gun from Joseph Reed, of Denver, Colo., and from J. W. Mullins, Fariston, Ky. (L. R., 808), asking if he could present an improvement of his gun to the board, and replies (Letter Book, pp. 1098 to 1100) sent.

The test of the Mauser No. 5 was then resumed in the presence of Mr. Alfons Mauser, the regular tests and the supplementary tests to include the preliminary portion of the rust test being completed, with results as in the synopsis.

The board then adjourned to the 26th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., July 26, 1892.

The board met pursuant to adjournment.

Present: All the members.

Letters (L. R., 810 and 811) were received from M. H. Durst, Hartford, Conn., with reference to his gun, and from the commanding officer Springfield Armory, acknowledging receipt of the Reed gun.

Additional supplementary tests were applied to the Roumanian Mannlicher, the Springfield single-loader No. 2, the Hampden No. 2, the Lee No. 3, and the Krag-Jörgensens Nos. 5 and 6, with results as in the synopsis of tests.

The board then adjourned to the 27th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., July 27, 1892.

The board met pursuant to adjournment.

Present: All the members.

The rust test of the Mauser No. 5 was completed, with results as in the synopsis of tests.

The board then proceeded to a consideration of the records of tests and to a discussion of the merits of the different guns examined, and later adjourned to the 28th instant.

SPRINGFIELD ARMORY,
Springfield, Mass., July 28, 1892.

The board met pursuant to adjournment.

Present: All the members.

A letter was received from the commanding officer Springfield Armory (L. R., 812), transmitting a caliber .30 Springfield rifle for trial by the board, and reply (Letter Book, p. 1101) sent.

The additional supplementary test of the Mauser No. 5 was completed, with results as in the synopsis of tests.

The test of the Springfield single loader No. 3 (above mentioned) was commenced, the safety test and the regular tests as far as to include that for endurance being completed, with results as in the synopsis of tests.

With reference to these trials the following report was made to the Chief of Ordnance:

OFFICE OF THE BOARD ON MAGAZINE ARMS,
SPRINGFIELD ARMORY,
Springfield, Mass., July 28, 1892.

SIR: In further reply to your letter of September 29, 1891, desiring the opinion of the Board on Magazine Arms as to the merits of the caliber .30 Springfield and its ammunition, regarded simply as a single-loading small arm, I have the honor to inclose, by direction of the board, the synopsis of the tests of the Springfield No. 3, yesterday received and to-day tested by the board, and with reference to that trial to remark as follows:

The gun was fired, in all, 724 times; in 172 instances the thumb piece of the cam-latch did not fall automatically into place as the breechblock was closed (as contemplated by the system), requiring, consequently, an additional motion from the operator.

After nearly every shot it was necessary to exert considerable strength to lift the cam-latch and open the block, and still more to operate the extractor and start the empty shell.

These difficulties made loading and firing a slow process, slower than with the caliber .45 Springfield, and much slower than the single-loader fire of the majority of good bolt guns.

Fouling collected as in the trials of the two other guns of this system, in the chamber and receiver, being blown out or wiped out by the operator from time to time; to this cause the board would to some extent ascribe the difficulties experienced with the gun, but not entirely, believing rather that they are partly inherent in the application of a system which, though found efficient for a larger caliber and lower pressures, is not well adapted to this reduced caliber and the high pressures caused by smokeless powder.

Very respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord. Dept., U. S. A., Recorder.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

The board then proceeded to a consideration of the records of tests and to a discussion of the merits of the magazine guns it had examined.

To afford time for the completion of the descriptions and drawings of the different guns before the board, it subsequently adjourned to meet at the Army Building, New York City, on August 19, 1892.

ARMY BUILDING,
New York City, August 19, 1892.

The board met pursuant to adjournment.

Present: Lieut. Cols. Hall and Farley, Maj. Freeman, and Capt. Blunt.

Absent: Capt. Anderson, at Fort Yellowstone, Wyo., by virtue of paragraph 4, Special Orders 179, Headquarters of the Army, of August 1, 1892.

The recorder laid before the board the letters received by him since the last adjournment. These included a request (L. R., 823) from M. H. Durst, Hartford, Conn., to exhibit the parts of his new gun now building; desiring dummy cartridges, the report of the board, or making various inquiries, from Gen. J. N. Reece, Springfield, Ill. (L. R., 816 and 820); James C. Fitzgerald, Pittsburg, Pa. (L. R., 817); J. H. Blake, New York City (L. R., 818); James L. Smith, Brooklyn, N. Y. (L. R., 821); Capt. R. M. Petersen, New York (L. R., 827), and Alfons Mauser, Hartford, Conn. (L. R., 830).

Letters with reference to the return of their guns which had been tested by the board, from J. W. Mullins, Fariston, Ky. (L. R., 813, 822, and 829); Capt. A. H. Russell, U. S. Army (L. R., 814 and 815); Arthur Savage, Hartford, Conn. (L. R., 819 and 824); Ivert Larsen, Chicago, Ill. (L. R., 825); John H. Blake, New York City (L. R., 826), and M. H. Durst, Hartford, Conn. (L. R., 828).

The recorder's replies (Letter Book, pp. 1105 to 1166) to these letters, and his various other communications, were also laid before the board. These included, among others, the following reports to the Chief of Ordnance: Upon the transactions of the board since June 8, 1892, the date of previous report (Letter Book, pp. 1105 and 1106); a report upon the sights and bayonets used on the magazine small arms of foreign nations (Letter Book, pp. 1125 to 1155), and a report of the progress of the work on the records of the board, and request for allotment of additional funds for payment of clerk, draftsman, etc. (Letter Book, p. 1163).

After examination, all this correspondence was approved by the board.

A letter (L. R., 831) was received from the Chaffee-Reece Arms Company, Washington, D. C., and reply sent (Letter Book, p. 1178).

The report of the board (Letter Book, pp. 1167 to 1177) was then forwarded to the Adjutant-General of the Army.

An examination of the records of the board and of the descriptions and drawings, as far as prepared, of the guns that had been subjected to test was then proceeded with, after which the board adjourned to the 20th instant.

ARMY BUILDING,
New York City, August 20, 1892.

The board met pursuant to adjournment, and finished the examination of those descriptions and drawings that had been completed.

The recorder reporting that the few unfinished drawings would be completed by the 25th instant, he was directed to forward them, with the record of the board, to the Adjutant-General of the Army on that date, after which, there being no further business before it, the board adjourned *sine die*.

ROBT. H. HALL,
Lieut. Col., Sixth Infantry.
J. P. FARLEY,
Lieut. Col., Ordnance Department.
H. B. FREEMAN,
Major, Sixteenth Infantry.
STANHOPE E. BLUNT,
Captain, Ordnance Department.
GEO. S. ANDERSON,
Captain, Sixth Cavalry.

STANHOPE E. BLUNT,
Capt., Ordnance Department, Recorder.

List of guns submitted, with exhibitors' address.

No.	Name of gun.	Exhibitors' address.
1	Lee-Speed (England)	Chief of Ordnance, U. S. Army, Washington D. C.
2	Krag-Jörgensen (Denmark)	Do.
3	Mannlicher (Austria)	Do.
4	Mauser (Belgium)	Do.
5	Infantry rifle, model 1888 (Germany)	Do.
6	Kropatschek (Portugal)	Do.
7	Murata (Japan)	Do.
8	Schmidt (Switzerland)	Do.
9	Mannlicher carbine (Austria)	Do.
10	Mannlicher (Roumania)	Do.
11	Model 1891 (Russia)	Do.
12	Berthier No. 1 (France)	Hotchkiss Ordnance Company, 1503 Pennsylvania avenue, Washington D. C.
13	Mauser No. 2	Alfons Mauser, Hartford, Conn.
14	Sporer	M. Sporer, Hartford, Conn.
15	Bruce No. 1	L. F. Bruce, Springfield, Mass.
16	Bruce No. 2	Do.
17	Krag-Jörgensen No. 2	Capt. O. Krag, Kongsberg, Norway.
18	Krag-Jorgensen No. 3	Do.
19	Krag-Jorgensen No. 4	Do.
20	Bruce No. 3	L. F. Bruce, Springfield, Mass.
21	Berthier No. 2	Hotchkiss Ordnance Company, 1503 Pennsylvania avenue, Washington, D. C.
22	Pitcher	Pitcher Arms Company, Neillsville, Wis.
23	Berthier No. 3	Hotchkiss Ordnance Company, 1503 Pennsylvania avenue, Washington, D. C.
24	Mauser No. 3	Alfons Mauser, Hartford, Conn.
25	Lee No. 1	Lee Arms Company, South Windham, Conn.
26	Lee No. 2	Do.

List of guns submitted, with exhibitors' address—Continued.

No.	Name of gun.	Exhibitors' address.
27	Mauser No. 4	Alfons Mauser, Hartford, Conn.
28	Krag-Jörgensen No. 5	Capt. O. Krag, Kongsberg, Norway.
29	Krag-Jörgensen No. 6	Do.
30	Ford	John Ford, Portneuf, Quebec, Canada.
31	Hampden No. 1	T. B. Wilson, Springfield, Mass.
32	Durst No. 1	M. H. Durst, Wheatlands, Cal.
33	Larsen	Ivert Larsen, 778 West Division street, Chicago, Ill.
34	Miles	Don D. Miles, Aurora, Ill.
35	Savage No. 1	Arthur Savage, 17 Adams street, Brooklyn, N. Y.
36	Mullins	J. W. Mullins, Fariston, Ky.
37	Chaffee-Reece	Chaffee-Reece Arms Company, Washington, D. C.
38	Blake No. 1	J. H. Blake, 136 Liberty street, New York, N. Y.
39	Lee No. 3	Lee Arms Company, South Windham, Conn.
40	Hampden No. 2	T. B. Wilson, Springfield, Mass.
41	Russell-Livermore No. 1	Capt. A. H. Russell, U. S. Army, Boston, Mass.
42	Russell-Livermore No. 2	Do.
43	Savage No. 2	Arthur Savage, 17 Adams street, Brooklyn, N. Y.
44	Fogerty	George Fogerty, 603 Main street, Cambridgeport, Mass.
45	Durst No. 2	M. H. Durst, Wheatlands, Cal.
46	Mauser No. 5	Alfons Mauser, Hartford, Conn.
47	Blake No. 2	J. H. Blake, 136 Liberty street, New York, N. Y.
48	Rubin (Swiss)	Chief of Ordnance, U. S. Army, Washington, D. C.
49	Schulhof, model 1888	Do.
50	Kelton	Gen. J. C. Kelton, Adjutant-General U. S. Army, Washington, D. C.
51	Springfield, caliber .30 single loader	Chief of Ordnance, U. S. Army, Washington, D. C.
52	Springfield No. 2	Do.
53	Springfield No. 3	Do.

PART II.—*Principal magazine arms before the board.*

NO. 1.—LEE-SPEED (ENGLAND).

(Pl. I.)

This gun, known as Mark I, is of the pattern of those issued for trial in the British service. The caliber is .303; the magazine, holding eight cartridges, belongs to the detachable type; having a cut-off, single-loading fire with the entire contents of the magazine in reserve is possible.

In the plate, Fig. 1 shows a longitudinal section and view from the right side when the bolt is entirely drawn back and the magazine full.

Fig. 2, the same in the firing position, magazine partly emptied.

Fig. 3, rear view of bolt, showing the handle bar and locking lugs in their positions in Fig. 1.

Fig. 4, section of bolthead and screw on B *b*, Fig. 1.

Fig. 5, longitudinal section of bolthead on A A, Fig. 6.

Fig. 6, rear view of bolt, showing the handle bar and locking lugs in the position in Fig. 2.

Figs. 7 and 8 give the top and end views of the dust cover of bolthead.

Fig. 9, section of magazine, spring, and follower, as in Fig. 1.

Fig. 10, section and rear view of receiver on C, Fig 2, showing position of cut-off (when open), chamber, extractor cut, and mortise for top of magazine.

Fig. 11, section on D, Fig. 2, showing dust cover, guide rib, and locking lug in firing positions.

Figs. 12 and 13 show a side and top view of the magazine follower.

DESCRIPTION.

The receiver (Figs. 1 and 2, and in Fig. 10 section and rear view on C, Fig. 2) has a vertical slot cut entirely through it for the purpose of receiving cartridges from, or loading them into, the magazine.

Its right face is partly cut away, affording a shoulder for the guide rib (A, Fig. 1) of the bolt when locked and a guide for the bolthead. The left face is slightly curved to the shape of the bolt, with at one portion a short ramp to bring the cartridges into the axis of the bore as they are pushed by the bolt into the chamber. Towards the rear the right face is brought up to the level of the left, and together they embrace and direct the motion of the bolt and its long guide rib. Shoulders (*a*, Fig. 10) at the bottom of the receiver afford an abutment for the magazine, and a curved ramp (*r*, Figs. 1, 2, and 10) in front, a surface up which the bullets pass as the cartridge is pushed forward by the bolt. In rear of the magazine slot is a spiral groove (*b*, Figs. 1 and 2), in which the lug (*c*, Fig. 1) on under side of bolt engages, and behind that is a vertical slot to permit the sear to reach, and a guideway to direct the motion of, the cocking piece.

The bolt is composed of the body and head. The body, cylindrical in general shape, is bored from end to end, the cavity being of three different sizes, largest at the front, to afford space for the shank of the head; smallest toward the rear, where only the body of the firing pin moves; midway is a shoulder, affording support to the mainspring when it is compressed.

On the under surface of the bolt is a lug (*c*, Figs. 1 and 11), which, with the opposite guide rib (*a*, Figs. 1 and 11), locks the bolt when in the firing position. At the rear and at right angles to the bolt is the operating handle (*h*, Figs. 3 and 6), which lies close (Fig. 6) to the stock when the breech is closed. Near the handle two longitudinal grooves (*e*, Figs. 1, 2, and 6) are formed on the under surface of the bolt, united by a short inclined groove or cam; in these a stud (*d*, Fig. 2) on the cocking piece engages as the bolt is rotated.

The bolthead (*a*, Fig. 5), which does not rotate with the bolt, is connected with the body by a screw (B, Figs. 1 and 4), which, passing through the guide rib and body, engages in a slot (*b*, Figs. 4 and 5) in the shank. Shank and head are pierced for the firing pin; the head is cylindrical and of the same exterior diameter as the body of the bolt, with a slotted rib for the extractor and spring corresponding to the guide rib of the bolt, and a lip (*b*, Fig. 3) to embrace the undercut rail (*c*, Fig. 10), which forms the outer surface of the right face of the receiver.

The firing pin is in one piece, the body (*f*, Fig. 2) cylindrical, the striking portion (*f'*, Fig. 2) gradually tapering to the point; a bushing at the junction of the two affords the forward support for the mainspring when compressed, and limits the motion of the striker by impinging against the rear face of the shank of the bolthead.

The pin screws into the cocking piece and is prevented from turning or becoming unscrewed by a cut in which a set screw (*a*, Fig. 2) engages.

The cocking piece (A, Figs. 1 and 2) has a milled head and a body of the same width as the guide rib and locking lug of the bolt; its front face (*f*, Fig. 1) constitutes the full-cock notch; it has a half-cock notch (*d*, Fig. 1). Like the bolthead, the cocking piece does not partake of the bolt's motion of rotation. The extractor and its spring (*c* and *d*, Fig. 5) lie, the latter entirely, the former mostly, within the slotted rib of the bolthead; when the bolt is closed the claw of the extractor enters the cut (*b*, Fig. 10) in the receiver.

The ejector (*g*, Fig. 1) is a stud formed by a screw, which, passing through the left side of the receiver, has its point projecting from the inner face.

The spiral mainspring, the trigger *t*, sear *s*, and sear spring *w*, which

also serves as the spring for the magazine catch, are fully shown in Figs. 1 and 2.

The magazine, Figs. 1, 2 and 9, is a sheet-steel box fitting in a mortice in the guard plate and stock, and abutting against the shoulders (*a*, Fig. 10) at the bottom of the receiver. On either side of the box are two corrugations (*g*, Fig. 2), forming guiding ribs along which the cartridges roll as they are forced upwards by the magazine spring; the rear portion of the sides are slightly turned in forming two lips, under which the heads are engaged in loading and which retain the cartridges against the pressure of the magazine spring.

The platform or cartridge carrier (Figs. 12 and 13) is hollowed to form a bed for the cartridges, and has on either side a projection (*a*, Fig. 13), which slides along the forward guide ribs of the magazine. Two tongues (*b*, Fig. 12) are punched out of the bottom of the platform to afford an attachment for the spring.

The magazine spring is of wire, one end resting on the bottom of the box, the other caught around the tongues of the platform. A rib on the back of the box has a shoulder, in which a spring catch engages to hold the magazine in position; this catch is prolonged, forming a small trigger (*t*, Fig. 2) in front of the main trigger of the gun; if withdrawn it permits the magazine to fall out by its own weight. A ring at the front with a two link chain secures the box to the guard swivel.

The cut-off (*d*, Fig. 10) is a flat plate pivoted near the front end and provided with a projecting thumb piece.

Supposing the gun to have been fired, the operations to remove the empty shell, reload, and fire are as follows: Immediately on commencing an upward pressure on the handle the stud (*d*, Fig. 2) on the cocking piece moving along the cam (*e*, Fig. 2) on the under side of the bolt withdraws the firing pin from the head of the cartridge; continuing the rotation of the bolt the locking lug enters the curved portion of the cut (*b*, Figs. 1 and 2) in the receiver and slightly cams back the entire bolt, starting the empty shell and continuing the partial compression of the mainspring. Drawing the bolt to the rear the half-cock notch and the face of the cocking piece pass over the point of the sear and the extractor withdraws the shell until its head striking the ejector it is deflected to the right; continuing the motion to the rear, the bolt passes the head of the upper cartridge in the magazine, which then slightly rises until held by the latter's turned over lips; motion of the bolt is finally stopped by its head abutting against the shoulder on the upper right face of the receiver. At this stage the position of the mechanism is as shown in Fig. 1.

Moving the bolt to the front it pushes the cartridge forward, the bullet rising along the ramp (*r*, Fig. 1) at the front of the receiver (this rising of the bullet is more marked as the magazine becomes partly emptied, its spring being then less compressed), the head sliding along under the lips of the magazine until passing them it rises smartly and engages under the claw of the extractor.

When the bolt reaches such a position that the cartridge is about four-fifths in the chamber the sear impinges upon the front of the cocking piece, preventing any further motion of the latter, and as the bolt is advanced giving additional compression of the mainspring. The final compression of the spring and seating of the cartridge is accomplished by the camming of the locking lug in the cut in the receiver as the handle is turned down.

The position of the mechanism at this stage is as shown by Fig. 2. Pressure on the trigger rotates the sear, and freeing the cocking piece permits the striker to reach the primer.

The shock of discharge is transmitted along the bolt to the long guide rib and locking lug on its rear half and sustained finally by the shoulder and cut in the receiver.

Gas ports (*p*, Fig. 1) are provided at the right and left of the receiver and in the bolthead to permit the free escape of gas in the event of a ruptured cartridge head.

The breech mechanism is provided with a dust cover (longitudinal section in Fig. 2, cross section in Fig. 11), but except limited portions on the bolthead (Figs. 6, 7, and 8), which serve as the guide lip and as a support for the extractor spring, the cover is not an essential feature of the system.

Grasping the milled head (*m*, Fig. 1) of the cocking piece with the thumb and finger the piece can be brought to either the half or full cock; in the first position the bolt can not be turned; the cocking piece must first be let down or else further retracted to the full cock. If when the bolt is withdrawn to eject the empty shell, the cocking piece be turned to the right, as by accident it readily can, or to the left, it will prevent the closing of the bolt.

A safety key, which engages in the notches *n* and *n*, Fig. 1, if opened when the bolt is closed and cocking piece down, locks the entire mechanism. It can not be operated when the sear is in the half notch.

If operated with the firing pin at full cock the bolt can be turned, but only partly withdrawn; operated when the bolt is further or entirely withdrawn it prevents the bolts closing.

If the trigger is pulled before the locking lug and guide rib are fully seated the stud (*d*, Fig. 2) on the cocking piece will (depending on the amount of rotation of the bolt) either pass along the short longitudinal groove under the bolt or strike full against the part separating the long and short grooves, in either case the striker will not reach the primer; or else it will strike the inclined edge of this separating portion next the long groove and complete the rotation of the bolt to the locking position before the striker impinges on the primer.

No. 2.—Krag-Jörgensen (Denmark).

(Pl. II.)

This gun, caliber .315, has been adopted by Denmark for its army.

The magazine holding five cartridges is of the fixed type, horizontal, under and also to the left side of the receiver. The gun has a cut-off; the magazine can therefore be held in reserve while single-loading fire is conducted.

In the plate, Figs. 1 and 2 show the mechanism assembled, the former after a shot has been fired and the empty shell ejected, the latter ready for firing.

Fig. 3 is a plan view of the magazine and its feed mechanism.

Figs. 4 and 5 are rear views of the assembled bolt, removed from the receiver and the former in the opened, the latter in the locked position.

Fig. 6, side and rear views of bolt body.

Fig. 7, side and rear views of extractor carrier.

Fig. 8, side and rear views of cocking piece and firing pin body.

Figs. 9 and 10, mainspring and striker.

Fig. 11, side and top view of extractor.

Fig. 12, cut-off.

Fig. 13, section of magazine and receiver on A A, Fig. 1.

Fig. 14, plan view of magazine and receiver, with section of magazine mechanism, gate partly opened.

Fig. 15, inside view of magazine mechanism when retracted into the entirely opened gate.

Fig. 16, ejector.

DESCRIPTION.

The receiver (Figs. 1, 13, and 14) is bored through longitudinally for the reception of the breech bolt and is also cut away on the right and partly on top to facilitate ejection of the empty shells and use of the arm as a single loader. Being closed on the bottom, it affords a smooth surface on which, or partly in the chamber, the cartridges would be placed when using the arm in this latter manner. On the left hand an opening or longitudinal slot (*a*, Fig. 1) of less width at the rear than at the front is cut, along and through which the cartridges pass from the magazine to the chamber, the motion of the point of the bullet being directed by the ramp *b* (Fig. 1). At the bottom of the receiver at its front end is a recess (*a*, Fig. 14) for the locking lug and at the front end of the left-hand wall is a ledge forming an abutment for the shoulder (*a*, Fig. 11) at the front of the extractor. The rib (*a*, Fig. 13) and ledge (*c*, Figs. 13 and 14) on right wall of receiver afford bearing for the locking lug (*a*, Figs. 4, 5, and 6) as the bolt is moved and for its guide rib (*b*, Figs. 5 and 6) when the bolt is in the firing position. The left wall of the receiver (*d*, Figs. 1 and 13) and the shoulder (*e*, Figs. 13 and 14) also guide this rib and the bolt as it is withdrawn. The tang of the receiver has a groove (*m*, Fig. 14), in which the nose of the cocking piece moves, and which prevents its turning with the bolt. The under face of the receiver (*f*, Figs. 1 and 13) is flat and smooth and forms the upper wall of the magazine. At the right of the receiver the curved shoulder *e b* (Fig. 14) serves to guide the rib of the bolt in its motion; its helicoidal surface *b*, with the locking lug recess *a*, gives the bolt its slow final forward motion as the handle is turned down into the slot *d* (Fig. 14); the rear face of this slot, the lower plane face of *b*, and the receiver *a* each sustains the bolt at discharge. At the bottom of the recess a small cut forms the receptacle for the ejector.

The bolt (Figs. 4, 5, and 6), with its operating handle, is in one piece, and is composed of the body (*d*, Fig. 6), the guide rib (*b*, Figs. 5 and 6), and the locking lug (*a*, Figs. 4 and 6). It is bored of one diameter except at the front, where a curved surface gradually closes it, permitting only the issuing of the point of the striker (*c*, Fig. 6). Below the handle the bolt is cut away, producing a helicoidal surface (*e*, Fig. 6) along which the nose of the cocking piece moves as the handle is turned upwards and into the depth of which it falls as the trigger is pulled; the base of the handle partly encircles to the left in the form of a projecting collar (*f*, Figs. 5 and 6) the body of the bolt.

The firing pin is composed of two parts, connected by a ball-and-socket joint, the striker (Fig. 10) and the body (Fig. 8). At the rear of the body is permanently riveted the thumb or cocking piece (*e*, Figs. 1 and 8); its upper projecting surface curved and checked to afford a firm hold for the thumb and fingers; its lower, provided with the half or safety and full-cock notches (*g* and *h*, Figs. 1 and 8). On the body of the pin and fitting into the interior of the bolt slides as a collar (Fig. 7) the extractor carrier. Underneath, this carrier piece has a cut (*a*, Fig. 7) to permit movement of the nose (*a*, Fig. 8) of the cocking piece, and above a groove (*c*, Fig. 7), in which the collar (*f*, Fig. 6) of the bolt handle turns. It is forked also (*b*, Fig. 7) to receive the shank (*c*, Fig. 11) of the extractor.

The mainspring (*a* and *b*, Fig. 9) when assembled on the firing pin is supported at one end by the circular band (*a*, Fig. 10) of the striker and at the other by the front face (*d*, Fig. 7) of the extractor carrier, as shown in Figs. 1 and 2.

The extractor (Fig. 11 and *k*, Fig. 1) is connected by a screw (*m*, Fig. 1) with the fork (*b*, Fig 7) of its carrier; the bevel (*b*, Fig. 11), affording a slight motion to the right, is of use when removing the bolt from the receiver. The hook of the extractor fits into a recess in the rear end of the breech chamber, into which it is guided by the spring projection (*a*, Fig. 11), engaging on a ledge on the left face of the receiver. From the shape of the extractor and its attachment to the carrier, it forms a spring with a tendency to lower the hook end, thus insuring the retention of its hold upon the cartridge head first secured as the hook enters the recess in the chamber.

The ejector (Fig. 16) fits in a cut on the bottom of the receiver slightly to the left of its axial line. The lower portion, in the form of a pin (*a*, Fig. 16), engaging a slot (*n*, Fig. 14) cut for its reception. When the bolt is closed the ejector takes the position indicated in Fig. 2 (*n*, and the broken line to the front); when the bolt is withdrawn the spring form of the ejector causes the point (*b*, Fig. 16) to rise, as shown in Fig. 1.

The sear spring (*c*, Fig. 1) is a broad, flat spring engaged on the sear, and resting at its other end on the bottom of the tang. When first pressing the trigger (*t*, Fig. 2) the point of the sear is lowered along the face of the full-cock notch, and at the same time the portion *r* (Fig. 2) of the trigger piece is brought into bearing; continuing the pressure, the cocking piece and firing pin are released.

The magazine (Figs. 3 and 13) lies below the receiver, which forms its top, and is an open casing having a flat bottom that merges into an upwardly curving rear wall (*b*, Figs. 3 and 13, also *f*, Fig. 14), partly closing the left side of the receiver. The right side or front of the magazine is closed by a gate (*g*, Figs. 13 and 14), locked in position by means of a spring latch (*a*, Fig. 15), operated by the thumb piece *h* (Figs. 13 and 15). The gate is pivoted to the magazine by a pivot screw and opens out horizoutally to the right, as shown partly opened in Fig. 14.

Within the gate lies the magazine spring (*k*, Figs. 3 and 14), having an arm (*l*, Figs. 14 and 15), which bears against the carrier-lever (*w*, Fig. 14, shown also in broken lines in Fig. 3) to the spoon-shaped head of which (*b*, Fig. 15) is pivoted the oscillating feed plate (*c*, Fig. 15). When the gate is closed and the magazine full the pressure of the cartridges forces the magazine mechanism within the gate, as in full lines Fig. 3.

The first four cartridges are brought up in the magazine by the pressure of the spoon of the carrier lever; the last rides upon the feed plate and is held in such a position that the face of the bolt impinges against its head.

As the gate is opened the stud *h* (Figs. 3 and 14) within the magazine impinging on the short arm of the carrier lever causes it to be retracted; and when the gate is fully opened (lying then at right angles to the receiver) to be wholly within the gate (Fig. 15 shows its position at such time).

The cut-off (Fig. 12) lies in a groove at the left of the receiver, within which, at the mouth of the magazine, by turning down the handle (*b*, Figs. 2 and 12) the blade (*a*, Fig. 12) is made to project and force down the cartridges (see Fig. 13), thus permitting single-loader fire.

Supposing a shot to have been fired, to remove the empty shell, reload, and fire, the mechanism operates as follows:

Beginning to turn the handle (from its position as in Fig. 5) upwards

and to the left, the nose of the cocking piece (*p*, Fig. 1) which was buried in the point of the cam on the bolt (*p*, Fig. 6), and which lying in the cut (*m*, Fig. 14) in the tang can not itself turn, is forced back along the cam from *p* towards *e* (Fig. 6), thus withdrawing the point of the striker from the primer and partly compressing the firing-pin spring until the sear engages in the half-cock notch. Continuing the motion of the handle, the retraction of the cocking piece and compression of the spring continue, and as the handle bears against the curved shoulder of the receiver (*e*, Fig. 14) the entire bolt is slightly carried to the rear, starting the empty shell. Just before the handle reaches the vertical, the full-cock notch (*h*, Fig. 1) passes the point of the sear, followed immediately by the nose of the cocking piece engaging in the notch (*n*, Fig. 6) in the body of the bolt just beyond the cam *p e*. The bolt can then be drawn back, the motion being limited by the locking lug (*a*, Fig. 6) striking the shoulder (*b*, Fig. 14). As the point (*b*, Fig. 16) of the ejector is passed a cut in the bolthead permits it to rise and stop further motion to the rear of the empty shell, which being held on the opposite side by the hook of the extractor is thrown upwards and to the right. The upper cartridge in the magazine also moves slightly to the rear as the bolt passes it. The mechanism will then be as shown in Fig. 1. Returning the bolt, this cartridge is pushed forward, the bullet entering the chamber and the body of the shell soon after passing into the receiver, after which subsequent movement of the cartridge is directly in the axis of the bore.

The base of the handle reaching the shoulder (*e*, Fig. 14) its subsequent motion is to the right, and, as the locking lug engages in its recess (*a*, Fig. 14) and the rear of the guide rib (*g*, Fig. 6) impinges upon the curved surface (*b*, Fig. 14), also slightly to the front, completing the introduction of the cartridge. The sear entering the full-cock notch just as the handle reaches the shoulder (*e*, Fig. 14), this slight forward motion of the bolt also further compresses the mainspring. The mechanism will then be as shown in Fig. 2.

In case of a miss-fire it is not necessary to withdraw the bolt to cock the piece, but it may be done either by turning the handle up and then back or by withdrawing the firing pin directly by means of the thumb piece (*c*, Figs. 2 and 8).

In a similar manner the mechanism can be brought to the half or safety notch position.

If the trigger is pulled before the bolt is entirely closed, the nose of the cocking piece acting on the cam *e p* (Fig. 6) will cause the bolt to rotate and become securely locked before the striker can reach and explode the primer.

The cut-off can be operated with cartridges in the magazine or with it empty and in any position of the bolt.

The magazine can be loaded with single cartridges or from a packet, the latter not forming, however, an essential feature of the mechanism.

No. 3.—Mannlicher (Austria).

(Pl. III.)

This gun has been officially adopted and issued to the Austrian army. It has also been supplied to Chili and other countries.

The caliber is .″315. Into the magazine box, which is fixed, is introduced from above, through the receiver, a metal packet holding five cartridges. The packet forms an essential feature of the magazine

mechanism, and after its cartridges have been fed into the chamber falls to the ground through a cut in the bottom of the box. There is no cut-off, and the contents of the magazine can not be held in reserve during single-loading fire; the latter fire can be maintained only when the magazine is empty.

The gun is therefore rather a repeating arm than a magazine arm, understanding by the latter designation one which carries a reserve or magazine of cartridges for a sudden emergency without interfering with its normal use.

In the plate, Figs. 1 and 2 show longitudinal sections and views from the right side, the former when the bolt is entirely drawn back and the magazine full (a packet having just been introduced), the latter with the bolt in firing position, magazine partly emptied. Fig. 3 shows a rear view of the bolt opened and removed from the receiver; Fig. 6 of it closed with the locking cam.

Fig. 4 gives the locking brace removed from the maneuvering piece—*c* the top, *b* the side, and *a* the sectional, view. Fig. 5 is a rear view of receiver and bolt, showing also the safety catch. Figs. 9 and 10 are longitudinal sections of the bolt, the former taken vertically, the latter horizontally. Fig. 8 is a cross section on B B; Fig. 9 and Fig. 16, two views of the bolthead.

The maneuvering piece and brace quoin is shown in Fig. 11, a top view; Fig. 12, a side view, and Fig. 7, which is a section on C C, Fig. 12.

Two views of the cocking piece are shown in Fig. 13 and two of the firing pin in Fig. 14. The extractor is given in Fig. 15. In Fig. 17 are the bolt stop and a side view of safety catch. The cartridge packet is shown in Figs. 18 and 20, and in Fig. 19, which is a section on A A, Fig. 2.

DESCRIPTION.

The receiver and casing (Figs. 1 and 2) in their forward portion are entirely cut away at the bottom and also partly on the right-hand side. The former cut is carried down through the stock and, with the lower portion of the box itself, constitutes the receptacle for the cartridges and the magazine packet. The front face (*a*) of the receiver, which is slightly hollowed out and is in the nature of an inclined ramp, is prolonged below the sides, abutting against the transom (*b*) of the box and with it forming the front interior face of the magazine.

The receiver cut is broadest at the rear, to afford space for the packet; the sides are each two plain surfaces connected by curved portions, along which the cartridge heads ride as the cartridge is pushed by the bolt from the packet into the chamber. The upper part of the left face is produced above the axis (prolonged) of the bore and serves as a bearing for the bolt when withdrawing or pushing home the cartridge. The rear of the forward half of the receiver is partly closed by a transom (*c*, Fig. 1), hollowed out above to permit the passage of the bolt, and cut away below to afford space for the packet catch (*d*, Fig. 1). Back of this transom the upper portion of the casing is continuous, but its lower portion is cut away until the recoil shoulder (*e*, Fig. 1) is reached.

The bolt (Figs. 9 and 10 and in Fig. 8, which is section on B B, Fig. 9), generally cylindrical in shape, is bored of four different diameters. The forward one affords space for the movement of the guide ring (*a*, Fig. 14) of the firing pin; the next contains the firing-pin spring; the third affords support to and centers the firing pin in its action, and by means of a stud (*a*, Fig. 10) prevents it from turning, and the last

serves as a sleeve for the maneuvering piece (Figs. 11 and 12) with its brace quoin (*a*, Fig. 12). On the right face of the bolt a cut (*b*, Fig. 10) with two mortises (*c*, Fig. 10) forms the receptacle for the extractor (Fig. 15). On the left face of the bolt is a channel (*d*, Fig. 10), in which the bolt stop (*a*, Fig. 17) engages to limit the withdrawal of the bolt. The bolthead (Fig. 16), pierced for the firing pin, screws into the end of the bolt and is prevented from turning by the claw of the extractor engaging in a cut (*a*) on its right side.

Pivoted below the bolt is the locking brace (Fig. 4, and *c*, Fig. 2). *a*, Fig. 4, shows the brace in section; *b*, the side view; and *c* as it appears viewed from above with the bolt removed.

The maneuvering piece and brace quoin (Figs. 11 and 12, and Fig. 7, which is section on C C, Fig. 12) carries the operating handle (*a*, Fig. 6).

It is limited in its forward motion by the shoulder (*e*, Fig. 10) in the interior of the bolt, and when the bolt is assembled is limited in its motion to the rear by a shoulder (*f*, Fig. 1), which withdraws the cocking piece (*n*, Fig. 1) and firing pin until the guide ring (*a*, Fig. 14) of the latter abuts against the shoulder (*f*, Fig. 10) in the bolt. In the forward movement the inclined ribs (*a*, Figs. 7 and 12) engage under the rails (*a*, Fig. 4) of the brace and force the latter down in front of the recoil shoulder (*e*, Fig. 1). Drawn to the rear the inclined ribs lift the recoil brace, freeing it from the shoulder and permitting the further withdrawal of the bolt.

The firing pin (Fig. 14) is in one piece and composed of the striker, guide ring, and body. The latter is cylindrical except for the flat cut (*b*, Fig. 14), which, with the stud *a* (Fig. 10), prevents turning.

The cocking piece (Fig. 13) screws loosely to the rear of the firing pin, is retained in place by the guides in the rear of the maneuvering piece, and can be removed only by a compression of the firing-pin spring in excess of that given when operating the mechanism.

No separate spring is required for the extractor, which from its form and the method of attachment to the bolt readily grasps and retains the head of the cartridge. Nor is there any separate ejector, the claw of the extractor engaging but one side of the cartridge head, while pressing the other side against the left face of the receiver rotates the shell and throws it clear of the gun.

The spiral main spring, the trigger (*t*), sear (*s*) and sear spring (*w*) are fully shown in Fig. 1.

The magazine (Figs. 1, 2, and 19) and trigger guard are in one piece, and, except where its transom *b* and the ramp *a* (Fig. 2) of the receiver meet, are separated by the stock from the receiver and casing, to which, however, they are secured by the guard screws (*d*, Fig. 2). The bottom of the magazine is open at the rear (*h*, Figs. 1 and 2) to permit the ejection of the empty cartridge packet; the remainder is closed by the plate (*e*, Fig. 2). The magazine mechanism consists of the main spring (*k*, Fig. 2), the feed spring (*b*, Fig. 2) with its screw and stud (*f*, Fig. 2) to prevent turning the carrier lever (*m*, Fig. 2), and carrier plate (*n*, Fig. 2); this entire mechanism is retained in the box by a screw pin (*o*, Fig. 2), around which it operates. When the packet is introduced its cartridges compress the mechanism, the packet is held by the catch *d* and its spring *g* (Fig. 1), and the position is as there shown. As cartridges are transferred to the chamber the carrier lever and plate rise between the sides of the packet, assuming the positions shown in Fig. 2 and in section on A A in Fig. 19.

The cartridge packet (Figs. 1, 2, 18, and 20) is of sheet steel, corrugated to give it stiffness and for security in handling. The lips at top

and bottom and the space for the heads retain the cartridges in position; the carrier plate and lever rise through it as its cartridges are transferred to the chamber.

Supposing the gun to have been fired, the operations to remove the empty shell, reload, and fire are as follows:

Drawing the handle smartly to the rear frees the mortise (*d*, Fig. 12) from the stud (*d*, Fig. 15) of the firing pin (which had operated to lock the handle from slight accidental blows) and also commences the compression of the firing pin spring, at the same time the brace quoin starts to lift the locking brace from the recoil shoulder. Continuing to withdraw the handle the main spring is entirely compressed about the same instant that the locking brace is free of the shoulder. Further motion of the bolt starts, extracts, and ejects the empty shell and permits the upper cartridge from the magazine to slightly rise until its head is in front of the head of the bolt. The mechanism is then in the position shown in Fig. 1, except that the magazine having then only four instead of five cartridges the carrier lever and plate will be about midway the two positions shown in Figs. 1 and 2.

Returning the bolt, its head pushes the upper cartridge out of the packet and into the chamber. After the locking brace passes the recoil shoulder the brace quoin forces it down into full bearing, and the point of the sear preventing further motion of the cocking piece and firing pin the mechanism is brought to the position shown in Fig. 2, ready for discharge.

There is no half or safety notch, but when the bolt is brought to the firing position (Fig. 2) the entire mechanism can be locked, preventing discharge or movement of the bolt, by turning the safety catch (Fig. 5) from the position *a* to that of *b*, its blade *c* engaging in rear of the maneuvering and in front of the cocking piece. After discharge this safety catch can also be used to prevent opening of the bolt.

If the trigger is pulled after the bolt is closed, but before the locking brace is entirely seated, the power of the firing-pin spring, acting through the cocking piece upon the shoulder (*f*, Fig. 1) of the maneuvering piece, will complete the locking before the striker reaches the primer; a discharge before the piece is securely locked is thus impossible.

No. 4.—Mauser (Belgium).

(Pl. IV.)

This gun has been officially adopted and issued to the Belgian army. It has also been supplied to the Argentine Republic and other countries.

The caliber is .301. The magazine box, capacity five cartridges, is underneath the receiver and in front of the trigger guard and of the fixed type, but so arranged that it can be readily removed for cleaning. It can be charged through the receiver with single cartridges, or the five can be stripped at once from a metal clip which embraces the groove near the rear of the cartridge, which has no flanged head; the clip is pushed out to the right as the bolt is closed and does not form any part of the magazine mechanism. The gun has no cut-off, but by firing the upper cartridge from the magazine, replacing it with another, and so on, a single-loading fire can be maintained with four cartridges in reserve.

In the plate (Figs. 1 and 2) are longitudinal sections, the former with

the bolt drawn back, magazine full; the latter with magazine partly empty, mechanism in firing position.

Fig. 3 is a plan view of receiver; Figs. 4 and 6 are rear views of the bolt and safety-locking mass; Fig. 5, a rear view of the bolt alone.

Fig. 7 gives two views of the extractor. Figs. 8 and 9 give a side view and a cross section of the loading clip and magazine before the cartridges have been stripped into the latter.

Fig. 10 is a section on B B. Fig. 2 showing the grooves *a a* for the lugs and the shoulders *c c*, in front of which they lock.

Figs. 11 and 12 show the firing pin and cocking piece.

Fig. 13, the sear, and Fig. 14 the loading clip.

Fig. 15 gives a plan view of the safety-locking mass.

DESCRIPTION.

The receiver and breech casing (Figs. 1 and 3), open at the top, and are cut away at the bottom and right-hand side to permit the entrance of rartridges from the magazine and the ejection of the empty shells. On the left of the receiver is a channel (*a*, Fig. 3) and on the right a flat surface (*c*, Fig. 3), along which the two locking lugs of the bolt slide as it is moved back and forth. These are prolonged through the casing (*a*, Fig. 10), permitting the passage of the locking lugs. Just back of the chamber the bottom of the receiver (*a*, Fig. 1) and the top of the casing (*b*, Fig. 1) form shoulders to support the lugs when in the firing position. Grooves through the rear part (*d*, Fig. 3) of the casing permit the bolt to be withdrawn when the stop (*e*, Fig. 3) is retracted. A channel (*f*, Fig. 3) in the tang affords passage for the nose (*f*, Fig. 1) of the cocking piece.

The point of the bullet is guided by the ramp (*b*, Fig. 3) as the cartridge is pushed by the bolt from the magazine into the chamber. The inclined surface (*m*, Fig. 3) at the rear of the casing cams back the bolt as the handle is moved up and to the left. The magazine abuts against shoulders on the under side of the receiver.

The bolt is a straight cylinder with handle at the rear and two locking lugs (*a* and *b*, Figs. 4 and 5) at the forward end. On the interior it is bored of two dimensions, for the striking portion and for the body, with main spring of the firing pin. In the left locking lug is a cut (*a*, Figs. 4 and 5) to permit passage of the ejector, and on top of the front end of the bolt is a recess with, towards its rear, undercut sides for the extractor (*d*, Fig. 1). At the rear of the bolt is a short cam (*c*, Fig. 5) to retract the firing pin at the first motion of the handle, and a notch (*b*, Fig. 5) in which the nose of the cocking piece rests when the bolt is withdrawn. Just back of the space for the main spring the interior of the bolt is threaded for the safety locking mass (*e*, Fig. 15 and Fig. 1). Besides containing the safety device this piece moves as a sleeve on the firing pin, supports the rear of the main spring, and guides by the cut (*c*, Figs. 1, 4, and 15) the nose of the cocking piece. When the bolt is turned down or up this safety-locking mass does not rotate, the bolt proper moving on the thread above-mentioned.

The firing pin (Fig. 11) is in one piece, but turned of three diameters, the forward or striking part (*a*, Fig. 11) being the smallest. The collar (*b*, Fig. 11) affords abutment for one end of the spiral mainspring (Figs. 1 and 2).

On the rear part of the body a spline (*c*, Fig. 11), which engages in a groove in the safety-locking mass (*a*, Fig. 15), prevents turning of the pin.

The cocking piece (Fig. 12) is a nut, which screws on to the end of the firing pin; its nose (*a*, Fig. 12) moves in the cut in the safety-locking mass, and that mass also covers as a sleeve the body (*b*, Fig. 12) of the cocking piece. It is thus impossible to cock the piece independently by hand.

From the manner in which the extractor (Fig. 8) is secured at the rear end and from its form no separate spring is required. The stud (*a*, Fig. 8) prevents its accidental removal and supports it when withdrawing the empty shell.

The ejector (*d*, Fig. 3) is shown in broken lines in Fig. 3. It is pivoted to a lug on the left of the casing, and with its spring (*n*, Fig. 3) lies within the loading-clip catch and in a recess in the bolt stop. The loading-clip catch (*s*, Fig. 3) retains lightly the clip and cartridges in the position shown in Figs. 1 and 9. After the cartridges are stripped into the magazine it is not necessary to remove the clip, as the forward motion of the bolt throws it out.

The trigger, sear, and sear spring are shown assembled in Figs. 1 and 2, and the sear in Fig. 13. The sear is pivoted to the rear transom supporting the magazine, which also affords a bearing for the spiral sear spring.

The magazine (Figs. 1, 2, and 8) is secured to the guard by the catch lever (*b*, Fig. 2). It is not removed for loading, but only for cleaning or repairs. Cuts (*a*, Fig. 8) on the sides and the turned-over lips of the top retain the cartridges under the pressure of the magazine spring, but yet yield sufficiently to permit their being stripped from the cartridge clip through the receiver directly into the magazine. The bottom of the box, hinged on the pivot (*b*, Fig. 8), is secured by the locking screw (*d*, Fig. 8), which also serves as the pivot for the carrier lever (*e*, Fig. 8). To the end of the latter the follower or carrier (*c*, Fig. 8) is pivoted. The two flat springs (*f* and *h*, Fig. 8) cause the follower to continually bear against the lower cartridge. When the magazine is empty the position of this mechanism is as shown in Fig. 8. When half full, as in Fig. 2; when completely charged, as in Fig. 1.

The cartridge clip (Fig. 14) is a thin, flat piece of steel bent over at the edges, forming a rebate to embrace the heads of the cartridges, which are cannelured and not flanged. Cartridges can be introduced into or stripped from either end of the clip, in which they are ordinarily held by a spring between their heads and the back of the clip.

Supposing the gun to have been fired, the operations to remove the empty shell, reload, and fire are as follows:

Turning the handle upward, the nose (*f*, Fig. 1) of the cocking piece lying in the cut (*f*, Fig. 3) in the tang can not itself turn, and therefore sliding up the cam (*c*, Fig. 5) on the back of the bolt slightly retracts the firing pin. The handle, which has been moving along the flat surface (*p*, Fig. 3), then reaching the cam (*m*, Fig. 3) in the casing moves the bolt backward, starting the empty shell. Until this point is reached the extractor has been following around the groove in the cartridge head. After the shell has been started, rotation of the bolt may either cause this motion to be continued or else cause the entire shell to turn in the chamber. When the handle has been revolved 90° the nose of the cocking piece falls into the notch (*b*, Fig. 5) in the end of the bolt, and there remains when the bolt is drawn back. Drawing back the bolt the empty shell is brought back, until struck by the ejector it is thrown sharply to the right. Motion of the bolt is finally limited by the bolt stop as the head of the upper cartridge in magazine rises in front of it. Pushing the bolt forward the point of the bullet rising

along the ramp at the front of the receiver (*b*, Fig. 3) enters the casing and then the chamber, while the cartridge sliding under the lips of the magazine finally rises between them to the axis of the bore. Before the forward motion of the bolt is completed, the cocking piece meeting the nose of the sear, further travel of the firing pin is stopped, and as the bolt is advanced and finally turned down to the right the piece is cocked. The mechanism is then in the position shown in Fig. 2.

If the trigger is pulled before the handle is turned completely down the nose of the cocking piece will strike on the end of the bolt between the notch (*b*, Fig. 5) and the cam (*c*, Fig. 5), and the striker will not reach the primer. Or if the bolt has been further rotated the inclined part (*c*, Fig. 12) of the nose will impinge on the cam (*c*, Fig. 5), completing the locking of the bolt. The piece can not be fired until the cocking piece penetrates to the depth of this cam. Premature discharge is thus impossible.

There is no half cock, but by the safety catch the mechanism can be locked either at full cock or after the firing pin has been released. In case of a mis-fire the bolt must be partly withdrawn, as well as rotated to the left, to recock the piece. It can never be cocked by hand.

No. 5.—Rifle—Model 1888 (Germany).

(Pl. v.)

This gun, caliber .311, has been adopted for the German army. The magazine box is fixed under the receiver and in front of the trigger guard. There being no cut-off, the arm can be used as a single loader only when the magazine is empty. The cartridge packet, holding five cartridges, forms an essential feature of the mechanism, and the cartridges in it must be introduced in the magazine before repeating fire is possible; they can not be held in reserve.

In the plates (Figs. 1 and 2) are longitudinal sections, the former with the bolt drawn back and a cartridge packet just introduced; the latter with the magazine partly empty, mechanism in firing position—

Fig. 3 gives views of the bolthead and of the extractor and ejector.
Fig. 4 is a rear view of the thumb piece or firing-pin nut.
Fig. 5, a rear view of the bolt in the maneuvering position.
Fig. 6, longitudinal section and rear view of the cocking piece.
Fig. 7, the firing pin.
Fig. 8, the safety lock and its spring.
Fig. 9, plan view of the carrier lever.
Fig. 10, the cartridge packet.
Figs. 11, 12, and 13, sections on A A, B B, and C C, respectively, Fig. 1.
Fig. 14, a plan view of receiver and breech casing.
Fig. 15, side, bottom, and top views of the bolt and ejector stop and its spring.
Fig. 16, the sear and its spring.
Fig. 17, side and front views of the assembled bolt, bolthead, and cocking piece in the firing position.

DESCRIPTION.

The receiver and breech casing (Figs. 1 and 14) is cut away at the bottom and partly at the right-hand side; the breech casing at the rear is closed except for the cut (*a*, Fig. 14) on top to afford passage for the

bolt handle and the projecting arm (*d*, Figs. 1 and 6) of the cocking piece. The locking lugs on the bolt move in the channel (*a*, Fig. 11) and on the rail (*b*, Figs. 11 and 14) of the receiver and further to the rear through corresponding cuts in the casing. Forward of the receiver the locking lugs move through the cuts (*a* and *b*, Fig. 12), until as that part of the left lug on the bolthead settles into the cut (*a*, Fig. 13) the lugs of the bolt engage in the receiver (*a*, Fig. 1) at the top and bottom, the sides of the right channel (*b*, Fig. 12) being so inclined as to cause during this movement a quarter rotation of the bolt.

A transom (*a*, Fig. 2) closes in front the receiver (and magazine), and has at its upper end a short ramp along which the bullets ride as they enter the chamber.

On the left of the casing is the bolt stop and ejector arm (Fig. 15, and *c*, Fig. 14). The ejector (*a*, Fig. 3) in the bolthead, abutting against the arm (*a*, Fig. 15), throws out the empty shell; the part (*b*, Fig. 15) striking the left locking lug limits the motion of the bolt. Pressure on the thumb piece (*d*, Figs. 14 and 15) compresses the spring (*c*, Figs. 14 and 15), withdrawing the stop and permitting removal of the bolt from the casing.

The bolt is composed of the body (Fig. 1) and the head (Fig. 3). The former is cylindrical, and except where contracted at the rear is bored of one diameter. At the front are the locking lugs (*b* and *d*, Figs. 5 and 17), and at the rear the cocking cam (*a*, Figs. 5 and 17), the notch (*e*, Fig. 5) for the safety lock and the notch (*c*, Fig. 5) for the point (*c*, Fig. 6) of the cocking piece to rest in when the bolt is withdrawn.

The left locking lug (*b*, Fig. 5) is bifurcated to permit passage of the ejector arm. In the bolthead this locking lug (*b*, Fig. 3) is continued, forming a receptacle for the ejector bolt (*a*, Fig. 3, and *e*, Fig. 17); a cut on its right side contains the extractor (*c*, Figs. 3 and 17). The shank of the bolthead is forked (*e*, Fig. 3) to permit movement of the part (*b*, Fig. 7) of the firing pin. The stud (*d*, Fig. 3) engaging in an annular cut on the interior of the bolt secures the head to the body of the bolt.

The firing pin is in one piece. The striking portion (*a*, Fig. 7) penetrates through the front of the bolthead and the part (*b*, Fig. 7) through its forks (*e*, Fig. 3); the ring (*c*, Fig. 7) guides its motion and affords the forward bearing for the spiral spring (Figs. 1 and 2) placed around the body (*d*, Fig. 7) of the pin. The cut (*e*, Fig. 7) in connection with the pin (*b*, Fig. 6) in the cocking piece prevents turning. The thumb piece (*l*, Figs. 1 and 2) screwing on to the firing pin (*f*, Fig. 7) affords means for cocking the piece without movement of the bolt.

The cocking piece (Fig. 6) embraces the rear of the firing pin, its projecting arm (*d*, Fig. 6), which provides a receptacle (*e*, Fig. 6) for the safety locking catch and its spring (Fig. 8), slides over the body of the bolt, as in *d*, Fig. 1. The cocking notch (*a*, Fig. 6) and the knob (*b*, Fig. 1) engaging in the groove in the lug (Fig. 2, and *e*, Fig. 14), prevents turning, while as the bolt is turned the cam (*a*, Fig. 5) and the surface (*c*, Fig. 6) move the cocking piece to the rear.

The extractor (*c*, Fig. 3), retained in its cut in the bolthead shank by the encircling bolt, from its shape requires no additional spring, nor is there any ejector spring, except as such a part is taken by the spring (*c*, Figs. 14 and 15) of the bolt stop.

The sear (Figs. 1 and 16) is pivoted to the lower part of the breech casing (*f*, Fig. 1), which also affords bearing for the spiral sear spring (*d*, Fig. 16); that part of the sear (*c*, Figs. 1 and 16) which engages in the cocking notch is riveted to the sear arm (*a*, Fig. 16); to the latter the trigger is also pivoted (Figs. 1 and 2).

The trigger (*t*, Fig. 1) rests constantly against the bottom of the tang; against the latter, just before discharge, the part (*e*, Fig. 1) comes into bearing.

The magazine is composed of the transom (*a*, Fig. 2) and of a box formed by producing the sides and bottom of the trigger guard, with which it is in one piece.

The cartridges in their packet (Fig. 10) are introduced into the magazine through the receiver, forcing down to the position shown in *h*, Fig. 1, the carrier lever. After all the cartridges have been transferred out of the magazine the packet falls to the ground through the cut (*b*, Fig. 2) in the bottom of the box. The turned-over lips (*a*, Fig. 10) retain the cartridges in the packet against the pressure of the carrier lever, and the catch (*e*, Fig. 2) retains the loaded packet in the magazine. The carrier lever (*h*, Figs. 2 and 9), pivoted to the box (*c*, Fig. 2), plays between the sides of the packet, bearing against the lower cartridge; further support to the cartridges is given by the ribs of the packet (*k*, Figs. 2 and 10) engaging in their grooved heads, and by the spring sides of the packet clasping the body of the case. The lever spindle (*d*, Fig. 2), actuated by its spiral spring, bears against the heel of the carrier lever (*a*, Fig. 9); as the lever is pressed down, as in *h*, Fig. 1, the spindle protrudes back into the recess (*m*, Fig. 2) in the stock, compressing the spindle spring, as in *m*, Fig. 1. As the magazine is emptied this spring causes the long arm of the carrier lever to rise, its face (*b*, Fig. 9, *h*, Figs. 1 and 2) being curved to afford a continued bearing against the lower cartridge.

After the gun has been fired the first movements of the handle (*l*, Fig. 1) to the left cause the point of the cocking piece (*c*, Fig. 6) to move along the cam (*a*, Fig. 5) on the back of the bolt; this withdraws the point of the firing pin from the cartridge and commences the compression of the main spring. When the quarter revolution of the bolt is about half completed the cam (*b*, Fig. 17) of the right locking lug meets the inclined surface by which the lower locking recess (*a*, Fig. 1) joins the channel in the casing (*b*, Fig. 12); the entire bolt is thus moved slightly to the rear, starting the empty shell. When the handle becomes vertical the nose (*c*, Fig. 6) engages in the cut in the bolt (*c*, Fig. 5), holding the spring compressed as the bolt is withdrawn, and at the same time the nose of the cocking piece (*a*, Fig. 6, *n*, Fig. 1) passes over the engaging point (*c*, Fig. 16) of the sear.

During the rotation of the bolt, the cocking piece and firing pin not turning the part *b* (Fig. 7) of the pin engaging in the forks (*e*, Fig. 3) of the bolthead, prevent rotation of the latter or of the extractor, the cut in the bolt moving over the stud (*d*, Fig. 3) on the head. When the bolt has nearly reached the position shown in Fig. 1, the ejector arm (*a*, Fig. 15), passing through the cut in the bolthead (*b*, Fig. 3), pushes forward the ejector bolt (*a*, Fig. 3), throwing the empty shell smartly out to the right. A cartridge packet can then be introduced into the magazine, as in Fig. 1, or if a shot has already been fired from it the passage of the bolt will permit the upper of the remaining cartridges to slightly rise in front of the bolthead. Pushing forward the bolt this cartridge will be forced forward, rising as its head leaves the front of the packet and entering the chamber. At the limit of direct forward motion the surface (*b*, Fig. 17) of the right locking lug meeting the interior cam in the casing gives a motion of rotation also completing slowly the seating of the cartridge. During this period, the sear preventing further forward motion of the cocking piece, compression of the main spring is completed.

The mechanism will then be in the position shown in Fig. 2, the bolt being further shown in Fig. 17.

The piece can be cocked by moving the handle up to the left and back again to the firing position, and also, though not easily, by grasping the nut or thumb piece (*l*, Figs. 2 and 17) and directly drawing back the cocking piece. When cocked the entire mechanism can be locked by turning the safety catch (Fig. 8) until the shoulder (*a*, Fig. 8) engages in the cut (*e*, Fig. 5) in the end of the bolt, the thumb piece of the catch (*o*, Fig. 8) passing from the position *o*, Fig. 17 to *p*, Fig. 17.

If the trigger is pulled before the bolt is entirely locked the part *c*, Fig. 6, *m*, Fig. 17, of the cocking piece will strike upon the cam (*a*, Figs. 5 and 17), and under the pressure of the mainspring will move along this cam, rotating the bolt to the locked position, which will be attained before the striker can reach the primer. The ease with which the nose (*c*, Fig. 6) can be thrown out of the notch (*c*, Fig. 5) in which it is engaged when the bolt is drawn back makes it possible by an accidental blow on the safety locking catch to cause the cocking piece to turn to the left, which, if not noticed and corrected, will bring the arm (*d*, Fig. 6) up against the left side of the breech casing, causing a jam as it is endeavored to close the bolt.

No. 6.—Kropatschek (Portugal).

(Pl. VI.)

The arm has been officially adopted and issued to the army of Portugal. The caliber is .315.

The magazine, holding eight cartridges, is tubular, and lies under the barrel. It is charged with single cartridges only, through the receiver. There is a cut-off.

In the plates, Figs. 1 and 2 show the mechanism assembled, the former after a shot has been fired and the empty shell ejected; the latter ready for firing.

Fig. 3 shows the position of the magazine spring when compressed.
Fig. 4 is a front view of the nut (*m*, Fig. 1) of the cocking piece.
Fig. 5 shows the body, and Fig. 6 the cocking piece, of the bolt.
Fig. 7 gives the thumb piece and shank of the cut-off.
Fig. 8 is a section on A, Fig. 2.
Figs. 9 and 10 are the hopper and the carrier lever and spring.
Fig. 11 is the firing pin.
Fig. 12 shows the bolthead.

DESCRIPTION.

The receiver and breech casing (Figs. 1, 2, and 8) are open at the top and the former cut away at the bottom and right-hand side. The plain vertical side walls of the receiver (*b*, Fig. 8) are prolonged downward and with the bottom (*a*, Figs. 1 and 8) form a box within which the hopper or cartridge carrier and its carrier lever and spring operate. This box is embodied in the stock and concealed from view. The front of the receiver is bored for the barrel and below the barrel for the magazine tube (*p*, Fig. 1).

The right-hand side face of the breech casing, behind the receiver, forms the support for the locking shoulder (*d*, Fig. 5) of the bolt when in the firing position.

The breech bolt consists of the body (Fig. 5, and *k*, Fig. 1), of the cocking piece (Fig. 6, and *h*, Fig. 1), and of the bolthead (Fig. 12 and *c*, Fig. 1). The body is bored of two dimensions, the front and larger one forming the receptacle for the firing pin and mainspring, the smaller a bearing for the body only of the firing pin. On the exterior is the locking mass and shoulder (*d*, Figs. 1 and 5), the arm (*b*, Fig. 5), projecting over the bolthead with a cut (*f*, Fig. 5) in which the shoulders (*a*, Fig. 12) move and which secures the head to the body of the bolt. The cuts *c*, *a*, and *e* (Fig. 5) permit the bolt to turn over the ejector and the projections *e* and *f* (Figs. 1 and 2), which operate the hopper. In the rear of the body is a cut (*m*, Fig. 5) for the shank of the safety lock and a cam (*n*, Fig. 5), which forces back the nose (*n*, Figs. 1 and 6) of the cocking piece as the bolt handle is turned. The channel (*p*, Fig. 5) permits direct motion of the body over the ejector and hopper studs.

The cocking piece contains two channels, one (*c*, Fig. 6) for the firing pin, the other (*e*, Fig. 6) for the safety lock and its spring. The nose (*n*, Figs. 1 and 6) operates along the cam (*n*, Fig. 5) of the body. The bolthead (*c*, Figs. 1 and 2 and Fig. 12) is pierced for the striker (*d*, Fig. 11) of the firing pin and has on its upper surface a cut for the extractor. When in the firing position (*c*, Fig. 2) the bolthead is only loosely joined to the body by its shank and by the firing pin; in the maneuvering position (Fig. 1) the shoulders (*a*, Fig. 12) engaging in the cut (*f*, Fig. 6) secure it to the body.

The firing pin (Fig. 11) passes through bolthead, body, and cocking piece. Through the cocking piece (itself constrained by the casing from rotation when the bolt handle and body are turned) a stud passes, which, bearing on the surface *a* (Fig. 11) of the pin, prevents the latter turning, and consequently, by the broad surface *b* (Fig. 11) of the pin which engages in the shank of the bolthead (*b*, Fig. 12) at the time of firing and of rotation of the handle, the bolthead and extractor are not permitted to revolve. The nut *m* (Fig. 1) secures the firing pin in the cocking piece under the tension of the main spring; the latter bears against the shoulder (*k*, Fig. 1) in the body of the bolt and the ring (*c*, Fig. 11) of the pin.

The extractor and its spring, a single piece, lie in the cut on the bolthead. When the bolt is withdrawn they are mostly covered by the arm (*b*, Figs. 1 and 6) of the body; when in the firing position they are placed as in *a*, Fig. 2, the spring bearing against the casing near the chamber.

The ejector (*i*, Fig. 1, *b*, Fig. 9) is a stud on the rear portion of the magazine hopper.

The sear (*n*, Fig. 2) is pivoted to the rear of the receiver, back of the magazine hopper; its spring (*n*, Fig. 2), attached by a screw to the sear, bears against the rear of the receiver.

The magazine, a metal tube, is placed concealed in the stock below the barrel; it extends from the receiver (*p*, Fig. 1) to a point about an inch below the front sight, where it is closed by a cap (*b*, Fig. 3), whose projecting shoulder secures it by rotation below a stud on the under side of the barrel. The spring, a long spiral, reaches with its attached follower (*a*, Fig. 3) to the receiver (*p*, Fig. 1) when the magazine is empty and is compressed to the position shown in Fig. 3 when the magazine is fully charged. The position of the cartridges when in the magazine is illustrated in Fig. 2. Cartridges passing in succession from the magazine are received on the hopper (Figs. 2 and 9), lifted to the position shown in Fig. 1, and then by the bolt pushed into the chamber. The carrier lever and spring (Fig. 10, and *l* and *o*, Fig. 1) lie

below the hopper, the latter bearing upon the plate (*a*, Fig. 1) closing the bottom of the receiver. The point (*c*, Fig. 10) of the lever spring serves as a cartridge stop when the hopper is down, as in Fig. 2, the arms (*s*, Figs. 1 and 9) of the hopper serving the same purpose when the hopper is raised as in Fig. 1.

The cut-off passes through the rear part of the hopper, the beveled portion of its shank engaging against the shoulders of the piece (*e*, Fig. 2) pivoted to (*r*, Fig. 1) the hopper. When its thumb piece (*a*, Fig. 7) is turned down the bevel on the shank pressing against the piece *e*, Fig. 2, depresses it below the action of the bolt and the gun becomes a single loader only; raising the cut-off brings the piece *e*, Fig. 1, to the position there shown, ready for magazine fire.

The spring (*c*, Fig. 7) acting in the cuts (*e*, Fig. 7) of the shank secures the cut-off to the hopper and also retains it as adjusted.

Presuming a shot to have been fired the operation of the mechanism is as follows: Turning the handle upwards and to the left, the cam *n*, Fig. 5) on the bolt forces back the nose (*n*, Fig. 6) of the cocking piece commencing the compression of the mainspring. When the motion is slightly more than half completed the shoulders on the bolthead (*a*, Fig. 12) will have engaged in the groove (*f*, Fig. 5) of the body and the face (*h*, Fig. 5) of the arm will bear against the cam at the front of the breech casing over the receiver; continuing the motion until the handle is vertical, the bolt and head will move slightly to the rear, starting the empty cartridge case, while the cocking piece passes over the point of the sear. Drawing the bolt to the rear the cartridge shell is withdrawn, being ejected when its head meets the ejector (*i*, Fig. 1; *b*, Fig. 9). Immediately thereafter the lower face of the front of the bolthead strikes the lug (*f*, Figs. 1 and 9), depresses the rear, and lifts the spoon portion of the hopper, the carrier lever under the action of its spring assisting in the motion as soon as its front (*a*, Fig. 10) is freed from the shoulders (*c*, Fig. 9) of the hopper.

The mechanism will then be in the position shown in Fig. 1.

Closing the bolt the cartridge is pushed into the chamber. As the handle is turned down, the front of the cocking piece abutting against the nose of the sear, the forward motion of the firing pin is stopped and the compression of the mainspring slightly increased while the cam on the right-hand side of the casing bearing against the shoulder on the bolt body (*d*, Fig. 1) continues a slight forward motion of the bolthead and body and cartridge. This rotation brings the cut (*e*, Fig. 5) on the bolt over the lug (*e*, Fig. 1) on the rear portion of the hopper and, as the cut gradually decreases in depth as the bolt turns, forces down the part *e*, which in turn raises the rear portion and lowers the front of the hopper to the position shown in Fig. 2, in which portion it is retained by the engagement of the end (*a*, Fig. 10) of the lever against the shoulder (*c*, Fig. 9) of the hopper.

The passage of cartridges from the magazine to the hopper is regulated by the forks (*s*, Figs. 1 and 9) at the front of the hopper and the point (*c*, Fig. 10) of the lever springs (*o*, Fig. 1). When, as in Fig. 1, a cartridge has been lifted from the magazine to the receiver, the forks *s* serve as the cartridge stop, lying before the head of the first cartridge in the magazine, while the point *c* of the lever spring lies beyond the head and below the body of this cartridge. When by the turning down of the bolt the hopper is lowered the lever (*l*, Fig. 1) and the rear part of the spring (*o*, Fig. 1) are also depressed, while the point (*c*, Fig. 10) slightly rises. As soon as the hopper and its forks *s* have passed the mouth (*p*, Fig. 1) of the magazine the first cartridge, under

the influence of the special magazine spring, flies into the hopper, the second following until its motion is stopped by its head meeting the point (*c*, Fig. 10) of the lever spring. The mechanism is then as shown in Fig. 2. When, as before explained, the hopper rises under the action of the bolt, the lever *l* and the part *o* of its spring also rise, while the point *c* is depressed sufficiently to clear the head of the cartridge then first in the magazine, permitting it to move from the position shown in Fig. 2 to that in Fig. 1, abutting against the forks *s*, while the point *c* lying as before below the body of the case is ready to repeat its action as stop to the second cartridge in the magazine.

The magazine is filled by first drawing back the bolt so easily that the blow on the lug (*f*, Fig. 1) will not lift the hopper from the position shown in Fig. 2, or if it is lifted it may be forced down again by direct pressure of the hand; the cartridges are then introduced singly through the mouth (*p*, Fig. 1), the head of each being in succession pushed, by the thumb, past the point *c* of the lever spring.

In operating the mechanism for magazine fire it is necessary to bring the bolt back (to the position in Fig. 1) with a fixed strength; if not brought back smartly enough the requisite blow will not be given the lug *f*, and a cartridge will not be lifted to the receiver; if brought back too strongly the cartridge may be thrown by the hopper clear out of the receiver. The piece is cocked by the simple turn up and then down of the bolt handle. Mechanically it should be possible to recock after a misfire by direct withdrawal of the nut (*m*, Fig. 1) and cocking piece, but owing to the interposition of the thumb piece of the safety lock and to the strength of the main spring it practically can not be accomplished. By the safety lock, of the form common to many bolt guns, the thumb piece when turned engaging in the cut (*a*, Fig. 4) of the nut on the cocking piece and the shank in the cut (*m*, Fig. 5) on the rear of the bolt body, the entire mechanism can be locked when at full cock.

No. 7.—Murata (Japan).

(Pl. VII.)

The arm has been adopted by the Government of Japan. The caliber is .315.

The magazine holds eight cartridges, is tubular, and lies under the barrel in a channel in the stock; it can be charged through the receiver with single cartridges only. There is a cut-off.

In the plate, Figs. 1 and 2 show the mechanism assembled, the former after a shot has been fired and the empty case ejected, the latter ready for firing.

Fig. 3 shows the position of the magazine spring when compressed.

Fig. 4 is a front view of the nut (*n*, Fig. 1) of the cocking piece.

Fig. 5 shows the body, Fig. 12 the head, and Fig. 8 the cocking piece of the bolt.

Figs. 6 and 7, the securing sleeve and bolt stop.

Fig. 9, the cut-off.

Figs. 10 and 14, sections of the hopper and carrier lever.

Figs. 11 and 13, the extractor and ejector.

Fig. 15, the hopper-maneuvering piece.

Figs. 16 and 17, the hopper and carrier lever.

Fig. 18, the firing pin.

DESCRIPTION.

While differing in some of the details of construction and dimensions and proportions of the parts, this arm is yet very similar in both its breech and magazine mechanism and in their action to the Kropatschek, described on pages 197 to 200 and in Plate VI, to which reference should be had.

The receiver is open at the top and bottom, with plain vertical sides, except that the left has a groove (*a*, Fig. 1) in which the ejector moves as the bolt slides back and forth. These sides form a box, concealed in the stock, which contains the magazine mechanism; the bottom of this box is closed by the guard (*b*, Fig. 1), which is screwed directly to the receiver, instead of, as with the majority of guns, to the stock. Near the bottom of the breech casing (which partly encircles the bolt), back of the receiver, is a channel permitting passage of the locking lug (*b*, Fig. 5) of the bolt, and at right angles to it a cut and shoulder beyond which this lug engages when in the firing position. The right-hand front face of the breech casing also affords a locking shoulder, supporting the handle base (*h*, Figs. 1 and 5) of the bolt.

On the front of the receiver, below the barrel, is the entrance to the magazine tube.

The breech bolt consists of the body (Fig. 5), the head (Fig. 12), and the cocking piece (Fig. 8). The body contains the mainspring and the greater portion of the firing pin. At the rear are the locking lug (*b*, Fig. 5) and the cam (*a*, Fig. 5), in which the nose (*a*, Fig. 8) of the cocking piece operates. The cut (*c*, Fig. 5) permits passage over the point of the sear (*a*, Fig. 2). In the bolthead are two channels (*a*, and *b*, Fig. 12), the former for the ejector (Fig. 13) and the latter for the extractor (Fig. 11); the cut (*e*, Fig. 12) permits passage over the nose (*e*, Figs. 1 and 15) of the piece by means of which the magazine hopper (Fig. 16) is depressed. The cuts (*e* and *f*, Fig. 5) perform the same functions as the corresponding ones (*e* and *a*, Fig. 5, Pl. VI) in the Kropatschek. Gas ports on the face of the bolt and on the side (*c*, Fig. 12) are provided. The body and head are connected by the bolt stop piece (Fig. 7, and *d*, Fig. 1), whose projecting arm (*d*, Fig. 1) engages over the shoulder (*d*, Fig. 12) of the head; the sleeve (Fig. 6, and *m*, Fig. 1) sliding over the bolt stop retains it in position. The cocking piece is provided with a guide rib (*b*, Fig. 8), which slides over the body of the bolt and through the channel in the breech casing; it is bored for the firing pin and has a stud which bearing on the flat surface (*a*, Fig. 18) of the pin prevents its turning. At its rear end a lug (*n*, Fig. 1, *c*, Fig. 8) engages in a cut (*n*, Fig. 4) of the cocking piece nut.

The firing pin and mainspring are similar to those in the Kropatschek.

The extractor (Fig. 11) lies in the cut (*b*, Fig. 12) with its tenon resting on the flattened surface (*n*, Fig. 12) of the shank of the bolthead, and entering with it the interior of the body of the bolt. From the form of the extractor no separate spring is necessary.

The ejector (Fig. 13) is placed in the groove (*a*, Fig. 12) in the bolthead, having a slight forward and back motion, which is limited by the shoulders (*c*, Fig. 13) and corresponding ones on the head, and by its abutment against the bolt body.

The magazine is similar to the Kropatschek, except that the cap closing the upper end (*a*, Fig. 3) is a part of the upper band, embracing the front sight base (*b*, Fig. 3) and carrying also the bayonet stud (*c*, Fig.

3). The hopper (Fig. 16) differs from the Kropatschek only in the omission of the ejector stud. The carrier lever and its spring (Fig. 17) are similar. The cut-off (Fig. 9) is also similar; the form (but not the operation) of its spring (*a*, Fig. 9) is, however, different.

The operation of the mechanism, both breech and magazine, is the same as for the Kropatschek, except as regards the action of the ejector. That lying in the bolthead is with it carried to the rear along the groove (*a*, Fig. 1) in the receiver until this groove, shallowing just before the motion of the bolt itself is stopped, the ejector is held, advancing it relatively with reference to the bolthead and giving a blow to the left side of the cartridge head.

In Figs. 14 and 10 cross-sections of the front end of the hopper and carrier-lever spring; their relative positions, as in Figs. 1 and 2, are shown, *a* in each being the forks of the hopper, *c*, the lever and spring; they serve the same purposes as in the Kropatschek.

The magazine is charged and the piece cocked by the same operations as for the Kropatschek. Not having a safety lock, it must, however, be carried at the full cock after a cartridge has been introduced into the chamber.

No. 8.—Schmidt (Switzerland).

(Pl. VIII.)

The gun known as the model 1889 has been officially adopted by Switzerland.

The caliber is .295.

The magazine lies under the receiver; its capacity is twelve cartridges and can be loaded through the receiver with single cartridges or by stripping from pasteboard packets containing six cartridges.

There is a cut-off, which operates to lower or raise the entire magazine as desired. The bolt handle has a simple rectilinear motion, without turn in the direction of the axis of the bore.

In the plate, Fig. 1 shows the bolt drawn back after firing one shot, eleven cartridges left in magazine. In Fig. 2 the magazine has been nearly emptied and a cartridge is in the chamber; mechanism in firing position.

Fig. 3 shows the bolt assembled and removed from the gun.

Fig. 4 is a longitudinal section of the handle guide and bolt stop.

Fig. 5 is the magazine cut-off.

Fig. 6, a cross section of the magazine and receiver.

Fig. 7, a cross section of magazine guide rib.

Fig. 8 is a plan view of the bolt body.

Fig. 9, side and bottom views of the cartridge packet.

DESCRIPTION.

The nearly vertical sides of the receiver curve out slightly toward the rear, where the receiver to accommodate itself to the broader top of the magazine is somewhat wider than near the chamber. Back of the receiver the breech casing is entirely closed with two helicoidal grooves (*a*, Fig. 2). on its interior joined at right angles by other grooves, whose rear surfaces form shoulders for the locking lugs (*a*, Fig. 3) of the bolt. At the right hand the casing also contains a rectilineal groove for the cylindrical guide (*b*, Fig. 3) of the handle (*h*, Fig. 3).

The bolt is comprised mainly of the cylinder or body (Fig. 8), with its exterior shoulder (*e*, Figs. 3 and 8), of the collar or nut (*d*, Fig. 3), which screws on to the body at the rear (*b*, Fig. 8), and of the sleeve which when assembled embraces and turns over that portion of the body between the collar (*d*, Fig. 3) and the shoulder (*e*, Fig. 3). Forward of the shoulder the interior of the bolt is bored for the striker (*a*, Fig. 1); back of it for the spiral mainspring and the body (*d*, Fig. 1) of the firing pin. In this latter portion of the bolt is a channel (*a*, Fig. 8), in which the stud (*c*, Fig. 3) of the handle guide engages. The forward portion of the bolt on either side is cut to a plane surface and has shoulders under which the magazine abuts when the bolt is closed; the surface on the left is further grooved to permit passage over the ejector. The collar has on its right-hand surface a channel for the rear stud (*f*, Fig. 3) of the handle guide and two cuts for the passage of the cocking stud (*f*, Fig. 2) of the firing pin when at the full and safety positions. Near the rear of the sleeve are the two locking lugs (*a*, Fig. 3) and forward of them a groove, rectilinear in front, helical in rear, in which the upper portion of the stud (*c*, Fig. 3) of the handle guide engages and by which the sleeve is given a motion of rotation as the handle is drawn back or pushed forward.

The firing pin is in two parts, the long striker (*a*, Fig. 1) and the body (*d*, Fig. 1) with ring (*h*, Fig. 1); they are assembled by the socket joint (*b*, Fig. 1). On the body of the pin is the cocking stud (*f*, Fig. 2).

The extractor (*n*, Fig. 3) extends forward from the shoulder (*e*, Fig. 3) of the bolt; it is retained in position by a stud on its under side engaging in an undercut recess on the bolt and by slight projections springing into corresponding notches on the bolt surface. The handle and guide (*h b*, Fig. 3), by means of which the bolt is operated, also serve to assemble its parts.

The guide, cylindrical on its upper surface (*b*, Fig. 3), has a groove of varying depth, which is shown in longitudinal section in Fig. 4 on its under side, and in which the bolt stop (*c*, Fig. 4) engages. On the guide are two projections or studs, one (*f*, Fig. 3) operating in the channel in the bolt collar and the other (*c*, Fig. 3) passing through the groove (*m*, Fig. 3) in the sleeve, and the channel (*a*, Fig. 8) in the bolt engages within the body of the latter just in front of the socket joint (*b*, Fig. 1) of the firing pin.

The trigger sear and sear spring are shown assembled in Figs. 1 and 2.

The magazine, a box holding 12 cartridges, arranged as shown in section in Fig. 6, is provided front and rear with projecting shoulders (Fig. 7), which slide, under the action of the cut-off, in grooves in the receiver. The cartridges lying on the stepped platform (*a*, Fig. 6) are lifted by the spring (*c*, Figs. 2 and 6), but retained in the magazine by the curved-in lips (*b*, Fig. 6) of its upper portion. The magazine is bedded in a rectangular cut in the bottom of the receiver, in the stock, and in the forward end of the bow of the guard plate. Connected with the latter is the cut-off (Fig. 5), a lever pivoted at *f*, Fig. 5, its long arm terminating in a thumb piece (*d*, Fig. 5) and its short arm (*c*, Fig. 5) in a stud (*a*, Fig. 5), operating in a groove (*b*, Fig. 5) on the side of the magazine. A curved arm (*e*, Fig. 5) is so notched (*m*, Fig. 5) as to retain the cut-off in the position adjusted. Lowering the thumb piece (*d*, Fig. 5) raises the entire magazine, bringing the upper cartridge in front of the bolt; raising the thumb piece lowers the magazine, leaving it in reserve and single loading fire possible. The magazine can be entirely removed if desired.

The cartridge packet is of pasteboard reënforced with a tin band

having two tugs (*a* and *b*, Fig. 9) to hold the cartridges in place; pressure from the thumb bends out the tugs and allows the cartridges to fall into the magazine.

The gun having been fired, the mechanism operates as follows:

Pulling back the handle (*h*, Fig. 3), which was held in position by the hook (*c*, Fig. 4) of the bolt stop engaging in the recess (*a*, Fig. 4) of the guide, the stud (*c*, Fig. 3) of this guide passes at first along the rectilinear portion of the groove in the sleeve, slightly compressing in the meanwhile the mainspring; when the stud reaches the cam (*m*, Fig. 3) of the sleeve, the rotation of the latter is induced, starting the lugs (*a*, Fig. 3) from the locking shoulders in the casing, and at the same time on account of the shape of the rear of these lugs moving back slightly the entire bolt, thus freeing the empty cartridge case in the chamber.

As the stud travels along the cam in the sleeve, the rotation of the latter continues until, when past the locking shoulders, the lugs enter the helical channels in the breech-casing, when the bolt can be withdrawn through and out of these channels until the hook of the stop (*c*, Fig. 4) enters the recess (*d*, Fig. 4) of the guide. At the same time the head of the cartridge strikes the ejector stud, and the empty shell is thrown out to the right, and the upper cartridge in the magazine rises in front of the bolthead. During the latter motion of the bolt the stud (*c*, Fig. 3) of the guide, engaging over a nose on the lower side of the cam (*m*, Fig. 3) of the sleeve, holds the mainspring compressed.

Reversing the movement and pushing the cartridge into the chamber, the motion of all parts of the bolt is at first directly forward, until the locking lugs enter the channels in the breech-casing, when a slow rotation is imparted to the sleeve; then, as the cocking stud (*f*, Fig. 2) meets the nose (*b*, Fig. 2) of the sear, the movement of the firing pin is stopped and additional compression given the mainspring. At the same time the more rapid rotation of the sleeve and the seating of the locking lugs take place, the movement ending with the passage of the stud (*c*, Fig. 3) of the guide along the rectilinear portion of the groove (*m*, Fig 3) in the sleeve and the entrance of the hook (*c*, Fig. 4) of the bolt stop into the recess (*a*, Fig. 4) of the handle guide. The position of the mechanism will then be as shown in Fig. 2.

No. 9.—Mannlicher Carbine (Austria).

(Pl. IX.)

This carbine, caliber .315, has been adopted for the cavalry of Austria-Hungary.

The ammunition and the cartridge packets are of the same size and interchangeable with those used in the Mannlicher rifle (Pl. III). The magazine holding five cartridges is similarly situated, and is alike in its general action, though the feed spring is somewhat different. There is no cut-off or provision for single loading fire with the magazine held in reserve; the arm therefore belongs to the type of repeating weapons.

Like the rifle the carbine mechanism is operated by a direct forward and back motion of the bolt handle, but, unlike the rifle, portions of the bolt turn and the locking is accomplished by this rotation.

In the plate, Fig. 1 shows the bolt entirely drawn back.

Fig. 2, closed for firing.

Fig. 3 is a rear view; Fig. 4, a plan view of bolt when removed from the gun.

Figs. 5, 6, 7, 8, and 9 are sections of the bolt as indicated in Fig. 4.

Fig. 10 is a top view of the safety lock.

Fig. 11 gives a view of the bolthead and spindle.

Fig. 12, a longitudinal section of the body of the bolt.

Fig. 13 is a top view of the guard and magazine spring removed from the piece.

Fig. 14, the cartridge packet.

Fig. 15, the firing pin and cocking piece.

Figs. 16 and 17, sections as indicated on Fig. 1.

Figs. 18 and 19, sections as indicated on Fig. 2.

DESCRIPTION.

The left face of the receiver extending upwards nearly to the top of the breech casing has on its surface a channel (*a*, Figs. 1 and 17) for the left shoulder (*a*, Fig. 4) of the bolt; this channel extends back through the breech casing, which also has on its opposite surface a similar but shorter channel for the right shoulder (*b*, Fig. 4) of the bolt. Below these channels are in the receiver shallow cuts and in the breech casing and tang under cut grooves in which the wings (*a a*, Figs. 6 and 16) on the under surface of the bolt are engaged. In the forward part of the receiver the channels (*a*, Fig. 1) merge into helicoidal grooves (*e*, Fig. 1), in which the shoulders (*c c*, Figs. 4 and 5) of the bolthead rotate as the bolt is closed or opened.

The walls of the receiver are, at its rear half, slightly cut away to afford increased space for the cartridge packet; the front of the receiver is a ramp up which the bullets pass as they enter the chamber; it also forms a portion of that side of the magazine box. In the tang are cuts for the ejector, the sear and the heel of the trigger or bolt stop.

The bolt (shown assembled in Fig. 4) is composed of the body (Fig. 12) with its operating handle (*h*, Figs. 4 and 12) and the head with its spindle (Fig. 11). On either side of the body, otherwise cylindrical, are the two shoulders (*a* and *b*, Fig. 4), which slide in the channels before mentioned in the breech casing and receiver; the left shoulder (*a*, Fig. 4, *c*, Figs. 6 and 7) is solid; the right (*b*, Figs. 4, 6, and 7) is solid in its rear half, but its forward portion is merely a shell, forming a receptacle for the spring portion (*d*, Fig. 4) of the extractor. On the under portion of the body are two short projecting pieces or wings (*a*, Figs. 6 and 16), which, engaging in the grooves in the tang, serve to retain the body of the bolt in its bearings when the shoulders are withdrawn from the channels in the casing. On the interior of the body for a portion of its length are two helicoidal ribs (*a a*, Fig. 12); through the next portion, narrowed by a short collar, only the firing pin passes and is prevented from turning by the screw (*d*, Fig. 12); the cocking piece moves in the rear part (*b*, Fig. 12) of the body and the safety-locking arm in the cut (*c*, Fig. 12). The body of the bolt has a motion of translation only as the mechanism is manipulated. The bolthead and its spindle (Fig. 11) are in one piece, the former of the same exterior dimensions as the body of the bolt, the latter smaller and moving within the body.

On the head are two locking lugs (*c*, Figs. 4, 5, and 11), which, as the bolt is being withdrawn through the casing, are in line with the shoulders (*a* and *b*, Fig. 4) and move through the same channels. The cut (*a*, Fig. 5) permits the ejector to rise and abut against the head of the cartridge. On the surface of the bolt-head spindle are two helicoidal grooves (*d*,

Fig. 11) corresponding to and engaging over the ribs on the interior of the body; also two straight cuts (*a* and *b*, Fig. 11); in the former the tang (*e*, Fig. 4) of the extractor rests when the bolt is in the maneuvering position (Fig. 4); in the latter, when closed for firing.

The firing pin is composed, in one piece, of the striker (*a*, Fig. 15) and body (*b*, Fig. 15); their junction is marked by the ring (*c*, Fig. 15), which affords the forward bearing for the mainspring. The cocking piece (*d*, Fig. 15) screws on the end of the firing pin, the stud (*f*, Fig. 15) moving when assembled in the groove in the tang. The nut closing the rear of the bolthead spindle furnishes the rear bearing for the mainspring.

The extractor lies partly within the right-hand shoulder of the bolt body, with its forward part embracing the bolthead. As the movement of the bolt causes the combined rotation and translation of the bolthead, the extractor, always remaining with its claw (*f*, Fig. 4) engaging over the head, moves back and forth between the position shown in Fig. 4 and one where the head is closed down on the body of the bolt. The part of the extractor within the shoulder (*b*, Fig. 4) not only secures it, but serves as a spring, whose heel (*e*, Fig. 4), resting in the cuts (*a* and *b*, Fig. 11) in the bolthead spindle, secures the bolt mechanism from a motion that might otherwise be given inadvertently.

The ejector (*b*, Figs. 1 and 2) is placed in the cut in the tang just back of the receiver and is pivoted to the sear (*c*, Figs. 1 and 2).

The trigger, when pressed in the usual manner, acts on the long arm (*e*, Fig. 2) of the sear and frees its nose (*c*, Fig. 2) from the cocking piece; if pressed forward, it lowers the projection (*d*, Figs. 2 and 18), which in its normal position acts as a bolt stop, and permits the entire withdrawal of the bolt.

The magazine is a box lying under the receiver and formed partly out of the guard plate; its capacity is five cartridges; the metal packet (Fig. 14) which contains them constitutes an essential part of the mechanism and is retained in the magazine when it contains cartridges or falls therefrom when empty in the same manner as in the Mannlicher rifle (Pl. III).

The magazine mechanism further consists of the spring (*m*, Fig. 2) and carrier lever (*n*, Figs. 2 and 13), of which the operation is sufficiently exemplified in the plate (Pl. IX).

Presuming the piece to have been fired.

Drawing back smartly the handle of the bolt brings the body to the rear, but the locking lugs, being in the position shown in Fig. 19, are engaged in front of the shoulders (*c*, Fig. 1) and retain the bolthead. As the body comes back the ribs (*a a*, Fig. 12) on its interior, operating in the grooves (*d d*, Fig. 11) in the spindle of the bolthead, cause the latter to rotate 90° to the left, while the inclined faces of the locking lugs (*c*, Fig. 4) and the corresponding surface of the locking shoulders (*e*, Fig. 1) give also to the bolthead a slight backward motion by which the extractor in conforming starts the empty shell. These motions also compress the mainspring. The bolt will then be assembled, as shown in Fig. 4, the locking lugs (*c*, Fig. 4) lying in the channel (*a*, Fig. 1) of the casing just forward of the magazine.

Drawing the bolt to the rear extracts the empty shell, which is ejected when its head meets the ejector; the wings (*a*, Figs. 6 and 16) then meeting the bolt stop (*d*, Figs. 1, 2, and 18), further motion of the bolt is stopped. Introducing a new cartridge packet the entire mechanism will be as depicted in Fig. 1. Advancing the bolt pushes the cartridge into the chamber. When the bolthead reaches the shoulders (*e*, Fig.

1) in the forward casing its direct motion is stopped, and continued pressure on the handle inducing the reverse rotation of the head and its spindle the locking lugs become seated in front of their recoil shoulders, as in Figs. 2 and 19. As this rotation begins the nose of the sear (*c*, Fig. 2) engages on the stud of the cocking piece and maintains the compression of the mainspring. The position of the mechanism will then be as in Fig. 2.

There is no half cock, but the mechanism can be locked after the bolt is closed either when at the full cock or after firing by means of the safety lock (*m*, Figs. 4 and 9, and Fig 10), one blade of the lock entering a cut in the tang and the other engaging in front (*m*, Fig. 15) of the cocking piece, if at full cock, or in the recess (*n*, Fig. 15) if after firing.

No. 10.—Mannlicher (Roumania).

(Pl. x.)

This arm has been adopted for the army of Roumania. The caliber is .256. The magazine lies under the receiver, and is very similar to the magazine in the Mannlicher carbine (Pl. ix). It holds five cartridges, which with the packet containing them are introduced through the receiver. There is no cut-off or provision for single-loading fire with the magazine held in reserve; the arm therefore belongs to the repeating type.

Unlike the two Mannlicher arms in use in Austria, in this latest model both the bolt and its handle rotate as the mechanism is operated, the direct pull back of the other Mannlichers not being a feature of the Roumanian rifle.

In the plate, Fig. 1 shows the action open and a packet just introduced into the magazine. In Fig. 2 the action is closed, some of the cartridges fired from the magazine and one ready for firing in the chamber.

Fig. 3 is a plan view of the receiver.

Figs. 4 and 5 give sections as indicated on Fig. 1. Figs. 9 and 10, sections on Fig. 2.

Fig. 6 shows the bolt as assembled when withdrawn from the gun, Figs. 7 and 8 being sections through the locking lugs and the rear face of the body.

Fig. 12 is a view of the firing pin.

DESCRIPTION.

The receiver (Fig. 3) is very simple in construction, its walls being plain vertical surfaces slightly further apart in the forward portion (*a*, Fig. 3) than in the rear (*b*, Fig. 3), where the receiver is widened to take the cartridge packet (*d*, Fig. 2). To the right, a shoulder (*d*, Figs. 3 and 5) furnishes a bearing for the right locking lug (*d*, Figs. 6 and 7) of the bolt as it is drawn back; this shoulder continues to the rear, as a groove (*d*, Fig. 4) through the breech casing. The left face of the receiver is prolonged upwards, constituting a channel (*c*, Fig. 5); this also is continued through the breech casing (*c*, Fig. 4), giving the left locking lug (*c*, Fig. 7) of the bolt and the ejector (*b*, Fig. 6) their support. A groove (*h*, Fig. 3) in the tang permits passage of the stud (*s*, Fig. 1) of the cocking piece. Forward of the receiver on the inte-

rior of the breech casing are two inclined grooves by which the locking lugs are cammed forward and into position in front of the locking shoulders (*a a*, Fig. 1) as the bolt is turned to the right.

The bolt shown assembled in Fig. 6 and in longitudinal section in Figs. 1 and 2 is composed of the body with its operating handle, the head, and the cocking piece. The body (*b*, Fig. 1) is bored in its middle portion to receive the firing pin and its spring; back of them the channel is reduced, forming a shoulder (*c*, Fig. 1), which furnishes the rear support to the mainspring; at the front end is a cylindrical groove in which the stud (*a*, Fig. 11) of the bolthead engages. On the surface of the body, near the rear end, is a cam (*c*, Figs. 6 and 8), by which the cocking piece is forced back as the bolt is turned to the left and the cut (*b*, Fig. 8) into which the spindle of the safety lock can be turned. At the forward end of the body are the two locking lugs (*c* and *d*, Fig. 7).

The bolthead has on its right-hand side a groove for the extractor (*b*, Fig. 11) and on the opposite side an undercut channel, in which the ejector (*d*, Fig. 11) is secured and operates. The shank (*e*, Fig. 11) embraces the flattened portion (*b*, Figs. 2 and 12) of the firing pin, and as the latter does not revolve during the movement of the bolt, the bolthead and the extractor and ejector have only a motion of translation in the direction of the bore as the mechanism is operated.

The cocking piece embraces the rear portion of the firing pin; its projecting arm (*e*, Figs. 1 and 6) slides over the body of the bolt and is the receptacle for the spring and spindle of the safety lock (*m*, Fig. 6). The cocking piece and bolt body are assembled by means of the mainspring and firing pin and the securing nut (*f*, Fig. 1) at the rear of the latter.

The extractor (*b*, Fig. 11) lies loosely in the cut in the bolthead, being there retained when assembled by the shoulder on its under side and by the body of the bolt; its rear portion (*f*, Fig. 11) constitutes a spring, bearing against the interior of the bolt.

The ejector (*d*, Fig. 11) is retained in its undercut groove of the bolthead by the screw (*c*, Fig. 11), which permits a slight movement in the direction of the axis of the bore.

The firing pin is in one piece and is composed of the conical point (*a*, Fig. 12); the flat portion (*b*, Figs. 2 and 12) which fits into the shank (*e*, Fig. 11) of the bolthead, the collar (*c*, Fig. 12) affording the forward support to the mainspring; the cylindrical spindle (*d*, Fig. 12) for the mainspring, flattened at one side to the rear (*e*, Fig. 12), where engaging against a screw stud on the interior of the cocking piece it prevents any rotation of the pin and consequently of the bolthead.

The trigger, sear, and sear spring are shown and their action indicated by the drawing (Figs. 1 and 2).

The magazine and its carrier lever and spring (*n* and *m*, Fig. 2) are very similar in construction and identically so in action to those of the Mannlicher carbine (Pl. IX). The cartridge packet (*d*, Fig. 2) holds five cartridges; it is retained (when having cartridges) in the magazine by the catch (*c*, Fig. 2) and its spring; pressure on the knob (*l*, Fig. 2) allows its removal. The overturned lips (*a*, Fig. 9) of the packet secure the cartridges; the carrier lever (*n*, Figs. 2 and 9) rises between the sides of the packet, and when empty the packet falls out of the magazine through the cut (*d*, Fig. 1) in the bottom of the box. The packet is smaller and lighter than that for the Mannlicher rifle and carbine of Austria and possesses the added advantage that it does not require the particular position in seating necessary in the Austrian arm.

After a cartridge has been fired the action of the mechanism is as follows:

Lifting the bolt handle turns the body of the bolt to the left, the cocking piece by its stud (*s*, Fig. 1), and that on the assembling nut (*f*, Fig. 1) lying in the groove (*h*, Fig. 3) of the tang can not turn, and consequently by the cam (*c*, Fig. 6) on the bolt body are forced to the rear. After the handle has about half completed its revolution the locking lugs begin to bear against the inclined grooves in the breech casing, which run into the locking recesses (*a*, Fig. 1), thus moving slowly back the entire bolt and starting the empty shell; as the rotation of the bolt is completed the nose (*f*, Fig. 6) of the cocking piece enters a slight recess in the rear of the bolt, which is to hold it secure as the bolt is withdrawn, retaining the compression already given the mainspring; at the same time the shoulder (*s*, Fig. 1) of the cocking piece passes over the nose of the rear.

Drawing the bolt to the rear removes the empty shell, the right locking lug (*d*, Fig. 6) sliding upon the right surface of the receiver (*d*, Fig. 3) and the left lug and the ejector running in the opposite groove (*c*, Fig. 3). When the ejector meets the ejector stud (*e*, Fig. 3) it is driven forward to the position shown in *b*, Fig. 6, the nose (*n*, Figs. 6 and 11) pushing out the left side of the cartridge head, which, as its right side is held by the extractor, is rotated sharply to the right and clear of the receiver. When the shoulder (*h*, Fig. 6) abuts against the left locking lug the ejector stud (*e*, Fig. 3) then becomes in its action a bolt stop, limiting further motion of the bolt to the rear.

A cartridge packet can be then introduced, as shown in Fig. 1, or if a cartridge has already been fired from the packet, the next, under the influence of the carrier lever (*m*, Fig. 2), will rise until its head lies in front of the bolt.

Pushing the bolt forward drives this upper cartridge out of the packet into the chamber. When the bolt is nearly forward the notch (*s*, Fig. 1) of the cocking piece impinges against the nose of the sear (*s*, Fig. 2); then, as the handle is turned to the right, the locking lugs enter the inclined grooves in the front breech casing, camming the bolt slowly forward, seating the cartridge, and completing the compression of the mainspring. The final motion of the handle merely seats the lugs in the locking recesses (*a*, Fig. 1).

In the rotation of the bolt the cams on the bolt and breech casing thus produce the entire compression of the mainspring, start the empty shell, and fully seat the cartridge. By the direct action of the bolt the shell is withdrawn and ejected and the new cartridge introduced.

In case of a miss-fire the piece can be recocked by turning the handle up and then back to the firing position without withdrawing the bolt; or, but not with so much ease, by grasping and drawing back the assembling nut (*f*, Fig. 1) of the cocking piece.

When the piece is cocked, moving the thumb piece (*m*, Fig. 6) to the right, throws the spindle of the safety lock into the recess (*b*, Fig. 8) in the end of the bolt, and locks the entire mechanism, permitting the gun to be carried loaded with safety.

If the trigger is pulled before the locking lugs are properly seated, the action of the nose (*f*, Fig. 3) of the cocking piece on the side of the cam (*c*, Fig. 3) of the bolt will throw the latter to the right, seating the lugs before the point of the firing pin reaches the primer.

No. 11.—Russian.

(Pl. xi.)

The arm is the one very recently adopted for the Russian army.

Having been obtained for test by the board with the understanding that it should be considered as confidential, its drawing and description are omitted from this report.

No. 12.—Berthier (France).

(Pl. xii.)

This system has been adopted for the French cavalry.

The arm submitted here for trial was, however, adapted to the caliber .30 Frankford experimental cartridge and was provided with a caliber .30 barrel.

The arm is not arranged for single-loading fire with magazine in reserve, and therefore belongs to the repeating class. The cartridge packet, somewhat similar to that for the German weapon, but holding but four instead of five cartridges, is introduced bodily into the magazine, and forms an essential portion of its mechanism.

In the plate, Figs. 1 and 2 show respectively the action open and closed. Fig. 3 is a plan view of the assembled bolt withdrawn from the gun but lying in the firing position.

Fig. 4 is a side view of the bolt body, with a broken section, showing the cuts in the well to receive the bolthead spindle.

Fig. 5 is a section on D D and Fig. 6 on E E, Fig. 1, to show the firing-pin clutch, while Figs. 7 and 8 are rear and side views of this same clutch.

Fig. 9 is a side view of the extractor.

Fig. 10, a rear view of bolthead sleeve.

Fig. 11, a side and front view of bolthead.

Fig. 12 is a section on A A, Fig. 1, showing the breech casing (*a* and *b*), the bolt guide rib (*d*), the sleeve (*c*), and the bolthead spindle.

Fig. 13 is a broken section of the system, showing the safety lock and its spring (*c*), the sear and packet spring (*d*), and the packet catch (*e*).

Fig. 14 is a section on B B, Fig. 2, showing the bolt body and spindle of bolthead, the magazine follower (*c*), and carrier lever (*b*).

Fig. 15 is a section on C C, Fig. 2, showing the position of the locking lugs, extractor, and bolthead when ready for firing.

DESCRIPTION.

The receiver is cut away at the bottom and on the right-hand side, the latter forming a shoulder on which the guide rib (*d*, Figs. 1 and 14) rests when the bolt is entirely closed. In the left wall is a channel (*a*, Figs. 1 and 14) for the passage of the left locking lug (*a*, Figs. 3 and 12). This is prolonged through the breech casing both in front and in rear of the receiver, and opposite such prolongation are corresponding channels in the casing for the right locking lug (*b*, Figs. 3 and 12). Inclined surfaces (*b*, Fig. 1) connect these channels with the locking recesses and shoulders in the forward casing. At the rear the upper

walls of the breech casing retain and direct the motion of the long guide rib (*d*, Figs. 3 and 4) of the bolt.

The bolt, shown assembled in firing position in Fig. 3, is composed of the body (*a*, Fig. 4), with its operating handle and guide rib (*d*, Fig. 4), of the bolthead and its spindle (Fig. 11); of the bolthead sleeve (Fig. 10, and *f*, Fig 3); of the cocking piece (*e*, Figs. 1 and 3), and of the firing-pin clutch (Figs. 7 and 8, and *m*, Figs. 1 and 3).

The cut (*b*, Fig 4) on the side and under surface of the bolt body and prolonged on the sleeve (*b*, Fig. 10) and bolthead (*b*, Figs. 11 and 15) permits passage over the ejector (*n*, Figs. 1 and 2) as the bolt is moved. In the well of the body are two cuts (one shown in *c*, Fig. 4) to receive the lugs (*a*, Fig. 11) on the spindle of the bolthead, by which connection the head is caused to turn with the body of the bolt.

On the rear of the body is a cam (*h*, Fig. 3) for throwing back the cocking and a recess (*r*, Fig. 3), which receives the nose (*s*, Fig. 3) of the cocking piece as the bolt is withdrawn. The locking lugs by which the discharge is sustained are on the bolthead (*c* and *d*, Figs. 11 and 15) lying vertically (Fig. 15) when in the firing position and horizontal, permitting passage through the channels in the casing when the bolt is withdrawn. During this latter operation they are prolongations of the guide lugs (*a* and *b*, Fig. 3) of the sleeve. Extending over the bolthead, but not connected with it, is the extractor (Fig. 4; *m*, Fig. 3; *a*, Fig. 15). The bolthead sleeve fits over the bolthead spindle and abuts against the front face (*b c*, Fig. 4) of the body. By a lug (*c*, Figs. 3 and 10), over which the cut (*o*, Figs. 3 and 4) rides when the bolt is brought to the maneuvering position, the sleeve and body are connected.

The extractor lies in the cut (*n*, Fig. 10) on the face of the sleeve, its hook projecting beyond it, over the bolthead; it is secured to the sleeve by hooked studs (*a a*, Fig. 9) on its under side. The guide lug (*a*, Fig. 3) never leaves the left channel (*a*, Figs. 1 and 14) in the receiver wall and casing.

The cocking piece has a projecting arm (*e*, Figs. 1 and 2) which lies over the rear of the bolt body, and a nose (*s*, Fig. 3) which operates along the cam (*h r*, Fig. 3) on the bolt body. At the rear and within the cocking piece is the firing-pin clutch, whose stud (*a*, Fig. 8), engaging in the end of the cocking piece, prevents any turning, and consequently, through the arms (*b*, Fig. 8), any rotation of the firing pin.

The firing pin is in one piece. It has a long protruding striker (*s*, Fig. 1), the collar (*a*, Fig. 2), which provides the forward bearing for the mainspring, and the body (*b*, Fig. 2), which passes the cocking piece and is secured by the clutch. The rear bearing of the mainspring is furnished by a shoulder in the well of the bolt body. From the peculiar construction of the bolt, with its bolthead spindle and sleeve, a long striker beyond the collar (*a*, Fig. 2) is necessitated, limiting therefore the space for the mainspring, which is consequently made short and stiff.

The ejector (*n*, Fig. 2) and its spring (*m*, Fig. 2) are placed below the breech casing, into which they are dovetailed.

The trigger (*t*, Fig. 2) is pivoted to the sear (*b*, Fig. 2). The sear spring (*s*, Fig. 2) also serves as a spring for the magazine packet catch (*p*, Fig. 2).

The magazine box lies below the receiver, hooking over two securing screws (*p* and *r*, Fig. 2). On the interior, shoulders (*f*, Fig. 2) form the front guide for the cartridge packet. The transom (*o*, Fig. 2) closes the interior of the magazine in front. The bottom of the box (*k*, Fig. 2) gives the bearing to the lower end of the carrier lever (*l*, Fig. 2), to which by a screw the follower spring (*d*, Fig. 2) is secured. Pivoted to the carrier lever is the follower (*c*, Fig. 2).

This magazine mechanism operates between the sides of the cartridge packet in the same manner as in the Mannlicher or German infantry guns, the packet when empty falling to the ground through the cut (*p*, Fig. 1) in the bottom of the box.

Presuming the gun to have been fired, the action operates as follows:

Turning up the bolt handle turns all of the bolt except the bolthead sleeve and the cocking piece. As the latter does not turn, the cam (*h*, Fig. 3) on the bolt, acting on the nose (*s*, Fig. 3) of the cocking piece, forces back the latter and commences the compression of the mainspring. After a turn of about 45° the nose of the sear (*b*, Fig. 2), which before any movement was made laid in the first notch (*q*, Fig. 1) of the cocking piece, passes into the half-cock notch (*r*, Fig. 1), and if the handle is turned back will hold the bolt in that position; but a moderate pressure on the trigger will, however, release it. Continuing the rotation of the handle, the point (*e*, Fig. 4) of the long guide rib comes in bearing against an inclined surface on the upper forward portion of the breech casing (not shown in the sections, but near to *f*, Fig. 1). This cams back the entire bolt and starts the empty shell. As the rotation is completed the full-cock notch (*t*, Fig. 1) passes over the nose of the sear. During this revolution the guide lugs (*a* and *b*, Fig. 3) of the bolthead sleeve remaining in the channels in the forward breech casing could not rotate with the bolt, and as the sleeve carries the extractor the latter also could not move.

Withdrawing the bolt, the ejector (*n*, Fig. 1) throws the shell out to the right, as the bolt-stop screw (*c*, Fig. 12) abutting against the lug (*a*, Fig. 3) limits further motion.

A new cartridge packet can now be introduced.

Pushing the bolt forward, it drives the upper cartridge into the chamber until the notch (*t*, Fig. 1) again meets the nose (*b*, Fig. 2) of the sear, and the point (*e*, Fig. 4) of the guide rib the cam (near *f*, Fig. 1) on the breech casing.

The handle, bolthead, and body then take up a motion of rotation, slowly seating the cartridge, securing the locking lugs (*c* and *d*, Fig. 15) in their recesses (*c*, Fig. 1), and completing the compression of the mainspring. The mechanism will then be as in Fig. 2; it can be secured from firing by the safety device (Fig. 13).

Pressing the thumb piece (*b*, Fig. 13) to the left, or backwards, moves the hook (*a*, Fig. 13) under the sear (*c*, Fig. 13), and prevents it being lowered by pressure on the trigger. The bolt is not locked by this device, but can be freely opened; it merely holds the sear inert.

No. 13.—Mauser No. 2.

This arm was submitted to the board by Mr. Alfons Mauser, of Hartford, Conn.

As far as regards the bolt and magazine mechanism, the gun is identical with the official arm of Belgium, previously described and illustrated (No. 4, Pl. IV), which see.

No. 14.—Sporer.

(Pl. XIII.)

This gun was brought before the board by Mr. M. Sporer, of Hartford, Conn.

The magazine reservoir, holding five cartridges, is in the butt stock, and from it through a tube the cartridges pass into the receiver. A cut-off permits the magazine to be held in reserve during single-loading fire.

In the plate, Figs. 1 and 2 show, respectively, the action open and closed. Fig. 3 is a plan view of the tube at the opening from the magazine, showing the slide (Fig. 5) in the act of compressing the magazine spring.

Figs. 4 and 5 show the magazine lever and its slide.

Fig. 6, two views of the sear.

Fig. 7, the mainspring.

Fig. 8, the safety lock.

Fig. 9, top view of the cocking piece.

Fig. 10, rear and side or top views of the bolt body in firing position.

Fig. 11, front and similar side views of the bolthead.

Fig. 12, the firing pin.

DESCRIPTION.

In one piece with the receiver is the upper portion (*m*, Fig. 1) of the magazine tube, giving the bottom of the receiver a sloping surface. Its right-hand side is cut away to the level of the cartridge stop (*n*, Fig. 1); its left (*p*, Fig. 1) rises to the level of the breech casing, forming a bearing for the bolt as it is moved back and forth. Back of the receiver the opposite sides of the casing rise to the same height, together forming a guide for the long rib (*d*, Fig. 10) of the bolt, the right-hand side giving also a shoulder against which the locking surface (*f*, Figs. 1 and 10) rests at time of discharge.

In the tang there is a groove for the notch of the cocking piece (*a*, Fig. 1) and a cut for the lever (Fig. 4, *e*, Fig. 1, *b*, Fig. 2), which operates the magazine mechanism and also serves as a cut-off.

The bolt is composed of the body (Fig. 10), the head (Fig. 11), and the cocking piece. As the handle is turned the cocking piece held upright by the breech casing can not turn; to it by the assembling nut (*h*, Fig. 1) and a stud on the interior bearing upon the flattened portion (*a*, Fig. 12) of the pin, the pin is also prevented from rotation. Passing through the body the striking portion (*d*, Fig. 12) enters the bolthead, and a spline on the part (*c*, Fig. 12) engaging in the cut (*a*, Fig. 11) in the shank of the bolthead prevents movement of the latter.

The extractor (*b*, Fig. 1), lying in the channel (*b*, Fig. 11) of the bolthead and its shank, has therefore no rotation around the cartridge head. In the bolt body a groove (*d*, Fig. 10), extended along the bolthead, (*d*, Fig. 11) permits passage over the ejector (*t*, Fig. 1), a screw stud fixed in the receiver. In the channel (*c*, Fig. 10) the lug (*c*, Fig. 4) of the magazine lever operates. On the rear of the body is the usual cam (*b*, Fig. 10) for forcing back the cocking piece and the recess (*a*, Fig. 10) for the forward part (*a*, Fig. 8) of the spindle of the safety lock as the latter is turned.

The shank of the bolthead slides into the well of the body, the notch (*e*, Fig. 10) on the projecting arm of the body engaging over the lug (*e*, Fig. 11) on the head as the former is rotated from the firing to the maneuvering position. The cocking piece has the usual notch (*a*, Fig. 1) and nose (*c*, Fig. 1) that bears upon the cam in the body. It also carries the spindle (*a b*, Fig. 8) of the safety lock. The front bearing of the mainspring (Fig. 7) is against the ring (*b*, Fig. 12) of

the firing pin, the rear against a shoulder (*d*, Fig. 1) in the well of the bolt body.

The sear arm is curved (*a*, Figs. 2 and 6) to give a reach around the magazine tube (*m*, Fig. 1).

The magazine (*m*, Fig. 2) is reached by opening the cover (*c*, Fig. 2), which operation, as the heel of the cover comes into bearing upon the lug (*f*, Fig. 2), retracts the follower (*d*, Fig. 2). The cartridges can then be introduced, their heads falling over the guide ribs (*g*, Fig. 2). Closing the cover the follower, acted upon by the follower spring (*e*, Fig. 2), bears down upon the cartridges, tending to push them in succession into the magazine tube (*r*, Fig. 1).

Presuming the piece fired, the action is then as follows: As far as regards that of the bolt alone in opening, extracting, ejecting, and again closing, the mechanism does not differ materially from others already described.

The peculiar features are those connected with the magazine. Drawing back the bolt the lug (*c*, Fig. 4) of the magazine lever, which lies in its receptacle in the breech casing back of the receiver (*b*, Fig. 2), passes along the channel in the bolt (*c*, Fig. 10) until it reaches its termination (*n*, Fig. 10). Further motion of the bolt moves the entire lever to the rear, and as its arm (*a*, Fig. 4) is engaged in the hook (*a*, Fig. 5, *e*, Fig. 1) of the magazine slide, the slide is also moved back. As it does so the shoulders (*c*, Figs. 3 and 5) engage against the flange of the cartridge, forcing it back and also the plunger (*p*, Fig. 2), thus compressing the magazine spring (*s*, Fig. 2). At the same time the swivel (*w*, Figs. 1, 2, and 5), riding up the ramps (*d*, Fig. 5) in the sides of the slide, passes from the position shown in Fig. 2 to that in Fig. 1, cutting off a second cartridge from the magazine tube. When the bolt is fully drawn back the spring sides of the slide, passing over shoulders (*a*, Fig. 3) at the base of the tube, open out from the head of the cartridge and releasing the latter, it, under the influence of the magazine spring, is shot forward under and past the cartridge stop (*n*, Fig. 1) to the position given in Fig. 1, from which the bolt, when closed, pushes it into the chamber. Closing the bolt reverses the movement of the lever (Fig. 4), and the slide (Fig. 5) opens the passage from the magazine to the tube and permits the cartridges to take the position shown in Fig. 2.

The operation of the cut-off consists in so turning the lug (*c*, Fig. 4, *b*, Fig. 2) out of the channel (*c*, Fig. 10) in the bolt that the shoulder (*n*, Fig. 10) does not strike it as the bolt is moved.

No. 15.—Bruce No. 1.

(Pl. xiv.)

This arm was brought before the board by Mr. L. F. Bruce, of Springfield, Mass.

The magazine lies beneath the receiver and is a hinged box revolving down and to the rear; its capacity is five cartridges.

The magazine can be cut off and held in reserve while the gun is used as a single loader.

In the plate, Fig. 1 shows the action open, magazine full.

Fig. 2, action closed, magazine partly empty.

Fig. 3 is a plan view of the receiver, bolt withdrawn.

Fig. 4, side and front views of the bolt and a section showing manner of securing the extractor hook.

Fig. 5 is a side view of the magazine open, cartridge charger being introduced.

Fig. 6 shows the reinforce ribs on the interior of the magazine box.

Figs. 7 and 8 are views of the safety lock and its spring.

Fig. 9 is a section of the bolt and handle seen from the rear, on A A, Fig. 2.

Fig. 10 a section on B B, Fig. 2, showing breech casing, locking lug extractor in the firing position.

Fig. 11 is the ejector and spring.

DESCRIPTION.

The receiver is cut away at the bottom (*d*, Fig. 3), and to permit the movement of the extractor also considerably on the right-hand side, forming a shoulder (*b*, Fig. 3) terminated in a ramp (*c*, Fig. 3), down which the locking lug (*c*, Figs. 4 and 10) moves as the boat handle is turned down to the right.

The left wall serves as a guide and support for the long rib (*a*, Fig. 1) of the bolt. In front the casing (*b*, Fig. 1) considerably overhangs the receiver with a helicoidal surface (*c*, Fig. 1) which, when the nose (*d*, Fig. 1) of the guide rib comes into bearing, cams the bolt around to the right.

In the tang, a channel (*e*, Figs. 1 and 3) permits passage of the cocking piece (*m*, Fig. 1).

The bolt, in the principle of its mechanism and most of the details of its construction, is very similar to the official arm of Denmark (Pl. II), though the relative proportions of some of the parts differ.

The form of the extractor is somewhat varied, the hook being thrown around to the right of the bolt (*b*, Fig. 4), though the arm (*a*, Fig. 4) is on top, as in the Danish gun.

The magazine cut-off (*m*, Fig. 3) is practically the same as on the Lee-Speed of England.

The magazine is composed of the follower (*e*, Fig. 2), within the right-hand part of which is a slide pivoted at *b*, Fig. 2, to the follower arm (*a b*, Fig. 2). At the other end of the follower another arm (*d e*, Fig. 2) is also pivoted. These arms are permanently pivoted (*a* and *c*, Figs. 2 and 5) to the sides of the magazine box. Joined to the arm (*a b*, Fig. 2) is the follower spring (*n*, Fig. 2). This system is actuated by the magazine mainspring (*f p*, Fig. 2). The box being empty and closed the magazine mechanism is operated as follows:

The system will be as in Fig. 2, except that the follower will be up in the box just below the bolt. The catch (*b m*, Fig. 5, *c m*, Fig. 2) will be in the cut (*n d*, Fig. 5) in the guard.

Drawing the catch down and to the left rotation of the box is induced, and at the same time the mainspring (*p m*, Fig. 2) attached to the catch is pushed to the left until the leaf (*f*, Fig. 2) passing beyond the point *b* the system of arms spring and follower is folded up and retracted upon the bottom of the box somewhat, but more closely, as shown in Fig. 1. Introducing then the cartridges, either singly or from a loading packet, as in Fig. 5, their heads enter beyond the guiding edge (*g*, Fig. 2) of the reinforce ribs (*g h*, Fig. 6) on either side of the interior of the box.

Swinging back the box the catch enters the cut in the guard and as the box is pressed up the edge of the cut (*d*, Fig. 5) bearing upon the side (*b*, Fig. 5) of the catch draws the latter forward and with it the

magazine mainspring until it assumes the position given in Fig. 1. As cartridges, under the action of the bolt, are transferred to the chamber, the system gradually rises, as in Fig. 2.

The forward motion of the catch and mainspring is limited by the stop screw (*p*, Figs. 2 and 5) entering the cut (*e*, Fig. 5).

The safety lock (Fig. 7) is a slide operated by the thumb piece (*f*, Fig. 3). The mechanism being in the firing position, drawing back the thumb piece moves the arm (*a*, Figs. 7 and 9) under the lug (*b*, Fig. 7) on the side of the bolt opposite the handle, at the same time the arm (*c*, Fig. 7) blocks the sear; the bolt can therefore not be moved nor the piece fired.

No. 16.—Bruce No. 2.

The Bruce, No. 1 (No. 15, Pl. XIV) having been withdrawn by Mr. Bruce for correction of some defects manifested in its test, was again submitted and entered on the records of the board as Bruce No. 2. In all essential particulars it is identical with the Bruce No. 1.

No. 17.—Krag–Jörgensen No. 2.

This arm was submitted to the board by Capt. R. M. Petersen, Royal Norwegian Navy (retired) and Mr. E. Jörgensen, representing Capt. O. Krag, director of the Royal Manufactory of Arms, Kongsberg, Norway.

In the principles of its mechanism it is similar to the official arm of Denmark (No. 2, Pl. II); the caliber, however, is .30, and it is otherwise adapted to the United States experimental cartridge.

The action of the ejector is slightly changed, being altered to a pivoted lever, one arm of which rises and strikes the under side of the empty shell as the other arm is depressed by the movement of the bolt. The half-cock notch on the cocking piece is omitted and a safety locking device, resembling in design and action that in the German infantry rifle introduced. The form of the thumb piece for independently drawing back the firing pin is changed.

No. 18.—Krag–Jörgensen No. 3.

The test of the Krag-Jörgensen No. 2 (No. 17 in list of guns) having shown the necessity of further head space for the cartridges, the counterbore was slightly reamed out. In all other respects the gun was similar to the Krag-Jörgensen No. 2.

No. 19.—Krag–Jörgensen No. 4.

Bolt similar to Krag-Jörgensen No. 2 (No. 17 in list of guns) except that it was provided with a dust cover.

Magazine similar to that on the Krag-Jörgensen No. 5 (No. 28 on list of guns), Pl. XV.

No. 20.—Bruce No. 3.

Bolt identical with that of the Bruce No. 2 (No. 16 on list of guns).

Magazine somewhat different, but with mechanism on a similar principle.

No. 21.—Berthier No. 2.

A second gun, identical with the Berthier, France (No. 12 on list of guns), Pl. XII.

No. 22.—Pitcher.

This arm was submitted by the Pitcher Arms Company, of Neillsville, Wis.

The mechanism is operated by a cover slide connected with a handle which has a direct forward and back motion only without rotation.

The receiver is in one piece, to which the breechblock is fitted, the front end of the latter admitting of a sliding motion, while the rear end of the bolt has in addition a vertical motion to lock and unlock.

For this purpose a mortise is formed vertically through the lower half of the receiver, while its upper half is grooved lengthwise from the barrel back to the rear. The mortise serves the double purpose of a receptacle for the magazine case and a shoulder to sustain the bolt under discharge.

Two latches, pivoted upon the upper side of the bolt in contact with the cover slide, impart vertical motion to the rear of the bolt to unlock the piece. A beveled surface upon the rear end of the breech bolt in conjunction with a rounded surface upon the under side of the cover slide closes and locks the piece.

The magazine is not inclosed in any box, but is skeleton in form, made of one strip or piece of spring steel with upright guiding rods at the front end and upright grooved surfaces bearing upon and flanged edges to retain the heads of cartridges at the rear end. The cartridges are lifted into position by a thin lever pivoted at the front of the magazine; upward tension is maintained by a short flat spring riveted to the frame underneath, and which has a bearing at its front end upon the front of the lever. A follower is pivoted at the rear end to the lever, a short flat spring being superimposed to cause the cartridges to assume the proper position as they enter the chamber.

The cartridges for the magazine are assembled in a binder, which is stripped off after they are introduced.

No. 23.—Berthier No. 3.

The trial of the previous arms on this system showing miss-fires, failures to extract and to properly feed cartridges from the magazine they were withdrawn for correction of these defects and one gun resubmitted.

The mechanism in its operation and the principle of its construction was identical with the previous arms. (See No. 12, Pl. XII.)

No. 24.—Mauser No. 3.

(Pl. xv.)

This arm was submitted by Mr. Alfons Mauser, of Hartford, Conn.

It differs from the Mausers Nos. 1 and 2 mainly in that it is provided with mechanism for cutting off the magazine and that it has an extractor which does not rotate around the cartridge head as the bolt is turned.

In the plate, Fig. 1 shows the magazine box lowered or arranged for single-loader fire.

Fig. 2 shows a bottom view of the guard with magazine removed.

Fig. 3 shows the cut-off lever and its friction screw.

Fig. 4 shows the extractor and extractor collar assembled on the bolt.

Fig. 5 gives sections of the bolt as indicated, showing position of extractor and collar.

Fig. 6, two views of collar.

Fig. 7, under side of the extractor.

DESCRIPTION.

The receiver is not changed from the other Mauser guns except by the introduction of the guide rib (*m*, Fig. 1) over which the cut (*a*, Figs. 4 and 5) in the left-hand locking lug moves as the bolt is moved forward or back. A recess, beyond that required for the right locking lug (*c*, Figs. 4 and 5), is made in the forward-breech casing to permit entrance of the hook (*d*, Figs. 4 and 7) of the extractor.

In the bolt the extractor is removed from its former fixed position. Around a circular groove in the bolt, back of the head, is bent a collar (*b*, Figs. 4, 5, and 6), terminating in two hooks (*b*, Fig. 6); this collar is free to revolve around the bolt. Another groove (*m*, Fig. 4) encircles about half the circumference of the bolt closer to the head.

The extractor (Fig. 7, *d f*, Fig. 4) has on its under side a channel, an undercut groove (*e*, Figs. 5 and 7), which engages over the hooks on the collar, and a rib (*m*, Fig. 7), which enters the groove (*m*, Fig. 4) near the bolthead. The rear portion of the extractor (*f*, Figs. 4 and 7) simply bears upon the body of the bolt. After the bolt is nearly closed, the hook of the extractor (*d*, Fig. 4), being engaged in the recess in the forward casing and the shank (*f*, Fig. 4) in the right-hand channel in the rear casing back of the receiver, can not partake of the bolt's motion of rotation, as the handle is turned down.

The magazine feed spring, follower, etc., are like those in the previous Mauser guns. The mechanism for cutting off the magazine is shown in Figs. 1, 2, and 3. By it the entire box and its contents is raised, bringing the upper cartridge in front of the lower part of the head of the bolt or it is lowered so that the bolt will pass over the cartridges without touching them. This is accomplished by the ratchet (*a*, Fig. 1) and the cogs (*c*, Figs. 1, 2, and 3) on the spindle of the cut-off lever. Lifting the thumb piece (*b*, Figs. 1, 2, and 3) from the position shown in Fig. 1, which is that when the magazine is cut off until the lug (*e*, Figs. 1 and 3) passes over the shoulder (*d*, Fig. 1) raises the box to the position for magazine fire. Lowering the thumb piece to the position (*f c*, Fig. 1) frees the cogs from the ratchet and permits the entire withdrawal of the box. The screw (*a*, Figs. 2 and 3) bearing on the spindle (*d*, Fig. 3) of the cut-off lever assists in retaining it as set.

No. 25.—Lee No. 1.

This arm was submitted by the Lee Arms Company, of South Windham, Conn.

It is practically the arm known as the Lee-Speed, Mark II, of England, and as regards the principle of its bolt and magazine mechanism does not differ from the Mark I of that system described as No. 1 in list of guns, and illustrated in Pl. I, to which reference should be made.

In the bolt, the bolthead is made longer, and the bolthead screw (B, Fig. 4, Pl. I.), which engaged in the slot (*b*, Fig. 5) in the shank of the bolthead, is replaced by a lug on the bolthead, which turns into a groove on the guide rib (*a*, Figs. 1 and 11), which is given a projection over it for that purpose. A channel on the side of the bolt and bolthead, intended to permit passage over the ejector-stud (*g*, Fig. 11), is made necessary in consequence of a slight change in the walls of the receiver.

The magazine is made broader and slightly shallower, permitting the cartridges to be arranged closer together than is shown in Fig. 9 (Pl. I), and increasing the capacity of the magazine to 10 cartridges.

The shape of the cut-off slide and its catch is slightly altered.

The dust cover is omitted.

No. 26.—Lee No. 2.

This arm was submitted by the Lee Arms Company, of South Windham, Conn.

The magazine is fixed, lies under the receiver, and holds five cartridges.

Both the bolt and the magazine, in the general principles of their mechanism, conform closely to other guns upon the Lee system, but as the arm was withdrawn by the inventor for correction on the conclusion of its first day's trials, and was not again submitted, no opportunity was afforded for the preparation of drawings or detailed description.

No. 27.—Mauser No. 4.

(Pl. xv.)

This arm was submitted by Mr. Alfons Mauser, of Hartford, Conn.

The magazine holds five cartridges and has no cut-off, but as with the Mauser of Belgium (No. 4 in the list of guns), the upper cartridge in the magazine can be replaced through the receiver after each discharge, thus obtaining what is equivalent to single-loading fire, with four cartridges held in reserve.

In the plate, Figs. 8 and 9 give a side view and section of the magazine box and receiver.

Fig. 10 shows the magazine mechanism; Fig. 11, the assembled bolt and extractor.

DESCRIPTION.

The receiver is the same as that in the Mauser No. 3 (No. 24 in list of guns), and has the same guide-ribs (*m*, Figs. 8 and 9) there mentioned.

The extractor and bolt are also similar to those in that gun, except

that the extractor, being stiffer and lying closer to the bolt, a recess (*d*, Fig. 11) has been made on the surface of the bolt, to lighten the spring of the extractor when it is turned therein, preparatory to removal from the bolt.

A cut (*c*, Fig. 11) is made, into which a lug connected with the sear engages as the trigger is pulled after the bolt is in firing position.

Until the bolt is locked this lug can not enter the cut (*c*, Fig. 11) and the piece can not be discharged.

The magazine box is fixed, but provision is made by which it can be quickly dismounted. Its sides have the overturned lips (*a a*, Fig. 9) to retain the cartridges common to all guns upon this system.

The mechanism consists of the follower (*a*, Fig. 10), the carrier lever (*c*, Fig. 10), and its spring (*b*, Fig. 10), and the spiral lever spring (*d*, Fig. 10), which, operating on the heel (*e*, Fig. 10) of the carrier, causes it to rotate about the securing pivot (*f*, Fig. 10).

Removing the cover (*n*, Figs. 8 and 10) the entire mechanism can be withdrawn from the box. In *m*, Fig. 10, is shown the appearance of the bottom of the box with mechanism removed.

No. 28.—Krag-Jörgensen No. 5.

(Pl. xv.)

This arm was submitted by Capt. Petersen and Mr. Jörgensen, representing also Capt. O. Krag.

As far as regards the construction of the breech bolt and its action the gun is very similar to the official arm of Denmark (Pl. II, No. 2, on list of arms before the board). The general principles of the magazine are also similar, but the construction and operation of the gate and magazine spring are somewhat different.

The gun has a cut-off. The capacity of the magazine is five cartridges, and it is adapted to the Frankford Arsenal experimental cartridge with flanged heads.

In the plate (Pl. xv), Fig. 12 is a longitudinal section of the bolt in the firing position, showing also the magazine space.

Fig. 13 is a plan view of the receiver, breech bolt removed, and of the magazine with gate opened. Fig. 14 is a section taken on A A, Fig. 13, and Fig. 15 one on A A, Fig. 12.

Fig. 16 is a face view of the follower and carrier lever.

Fig. 17, two views of the lever spring, and Fig. 18, an interior view of the magazine gate.

DESCRIPTION.

The bolt differs from the Danish gun in the absence of a half-cock notch on the cocking piece and the introduction of a safety lock similar to that on the German and several other small arms. The lock is operated by a thumb piece (*b*, Fig. 12), which causes a spindle to turn down into a notch (*a*, Fig. 12) in the body of the bolt. This locks the firing pin when in the firing position and also prevents the opening of the bolt. The form of the thumb of the firing pin and cocking piece (*c*, Fig. 12) is slightly altered, though its action is not.

For the flat sear spring (*s*, Fig. 2, Pl. II) a spiral spring (*d*, Fig. 12) has been substituted.

The ejector (*e f*, Figs. 12 and 13) is placed in a cut in the bottom of

the receiver. A channel in the lower side of the bolt, extending nearly to the bolthead, permits it to pass freely over the ejector (as in Fig. 12) until in withdrawing the bolt the head strikes the knob (*e*, Fig. 12), causing the longer arm of the lever (*f*, Fig. 12) to rise, and with a blow on the cartridge shell throw it clear of the receiver.

The magazine space itself (*b d*, Fig. 14) does not, as in the Danish gun (*f*, Fig. 14, Pl. II), project beyond the left face of the stock, though it does (*c*, Fig. 13) protrude slightly beyond the receiver.

The bottom (*d*, Figs. 14 and 15) of the magazine is flat; the left face (*e*, Figs. 14 and 15) slightly curved, the top flat (*a*, Figs. 14 and 15) and slightly cut away (*f*, Fig. 12), to allow free movement to the flanges of the cartridges. As in the Danish gun, the magazine mechanism is supported by the gate or cover, into which it is entirely retracted when the gate is opened. The gate is hinged horizontally and opens downwards instead of, as in the Danish gun (Fig. 14, Pl. II), swinging out to the right. The gate is secured to the magazine by the hinge pin (*h*, Figs. 13, 14, and 15). This pin also retains in a cut below the magazine the lever spring (Fig. 17, and *c*, Figs. 14 and 15). The arbor (*a*, Figs. 13 and 16) of the carrier lever engages in a bearing (*a*, Fig. 13) just without the magazine.

The action of the mechanism is as follows: The gate being closed, the mainspring bearing upon the right side of the heel (*e*, Figs. 16 and 17) of the carrier lever throws it forward (*b*, Fig. 13) into the magazine, the follower (*d*, Figs. 13 and 16) near its left face. This tends to advance a cartridge from *d*, Fig. 14, around toward *b*, Figs. 14 and 15, causing it to rise from the face up on to the top (*d*, *f*, Fig. 16) of the follower, which will then be in the position shown in section in *b*, Fig. 15. Opening the gate (Figs. 13 and 14) the lug (*b*, Fig. 18) comes into bearing upon the surface *c*, Fig. 16, on the heel of the lever and retracts the lever and follower from the position shown in broken lines *b d*, Fig. 13, to that in full lines in the same figure. A section of the latter position of the carrier is also shown in *n*, Fig. 14.

The gate is opened and shut by pressure upon the thumb piece (*m*, Figs. 13, 14, and 18). When in the first position cartridges can be introduced into the magazine through the opening *n*, Figs. 13 and 14.

A cut-off (*p*, Fig. 13) turns a spindle, which closes a passage (*b*, Figs. 14 and 15) from the magazine to the receiver.

No. 29.—Krag–Jörgensen No. 6.

This arm was submitted by Capt. Petersen and Mr. Jörgensen, representing also Capt. O. Krag.

It is exactly similar to the Krag-Jörgensen No. 5 (No. 28 on list of guns before the board), Pl. XV, except that it is adapted to a cartridge without flanged head instead of to the Frankford Arsenal experimental cartridge. This necessitates some few changes in the magazine, but none in its action or the principle governing the system.

No. 30.—Ford.

This arm was submitted to the board by Mr. John Ford, of Portneuf, Province of Quebec, Canada.

It had a fan-shaped magazine under the receiver, holding five cartridges, which were arranged in receptacles with separating ribs between.

There was a cut-off. Not passing the safety test in a satisfactory manner, it was after a few minutes, trial withdrawn by the inventor for correction, but not being resubmitted no opportunity was afforded to prepare drawings or description.

No. 31.—Hampden No. 1.

(Pl. xvi.)

This arm was submitted by Mr. Thomas B. Wilson, of Springfield, Mass.

Its bolt is identical with that of the Hampden No. 2 (No. 40 of the arms before the board), Pl. xvi. Its magazine is also the same, except that the follower and spring in the cartridge packet are omitted and the cartridges are fed down from the packet to the receiver by gravity alone.

No. 32.—Durst No. 1.

(Pl. xvii.)

This arm was submitted to the board by Mr. M. H. Durst, of Wheatlands, Cal. Its magazine, cylindrical in shape and having a capacity of ten cartridges, lies directly below the receiver. It can be loaded with single cartridges or they can be stripped from a clip, as with the Mauser gun. The gun has a cut-off.

In the plate, Fig. 1 shows a longitudinal section of bolt and magazine with action open; Fig. 2, the same with action closed. Fig. 3 is a plan view of the magazine and bolt in firing position. Fig. 4 is a cross section of bolt, bolthead, sear spring, etc., on A A, Fig. 1. Figs. 5 and 6 are sections of the magazine and receiver on B B, Fig. 1, the former with magazine open, the latter with magazine cut off. Fig. 7 is a side view, and Fig. 8 a front view, of the magazine casing and box.

DESCRIPTION.

The side walls of the receiver, immediately below the line guiding and supporting the bolt in its travel, spread out to the right and left, forming the upper portion (*a c* and *b c*, Figs. 5 and 6) of the magazine box.

Above this line the left wall (*c*, Figs. 1 and 5) is produced upwards, the right wall flattened, forming a shoulder for the guide rib (*b*, Figs. 1 and 3) when in the firing position. Channels are cut in the forward part of the breech casing for the extractor and for the thumb piece (*m*, Fig. 3) of the bolthead.

The bolt consists of the body (*b*, Fig. 1) with its operating handle (*h*, Fig, 1), of the bolthead (*n m*, Fig. 1), and of the cocking piece and firing pin (*p*, Figs. 1 and 2).

The rib (*b*, Figs. 1 and 3) serves to guide the bolt when drawn back through the rear part of the casing. The rear portion (*d*, Fig. 1) also

bears against the shoulder (*d*, Fig. 3) of the casing to lock the bolt and sustain the shock of discharge. The spindle of the bolthead (*a*, Fig. 1) fits into the well of the body, the lug (*n*, Figs. 1 and 3) engaging in a recess in the guide rib to connect body and head. The firing pin is screwed into the cocking piece, the set screw (*e*, Fig. 1) preventing any rotation.

The extractor, lying in a channel in the bolthead, is not turned with the bolt. The ejector (*f*, Fig. 1) is placed in the left side of the rear part of the breech casing.

The upper part of the magazine box is formed of the curved walls of the receiver; the lower part (*a d a*, Figs. 5 and 6), made in one piece with the trigger guard (*d*, Fig. 7), completes the truncated cone covering the magazine.

The magazine proper is a thin case of steel (*e*, Fig. 6), made in the shape of a truncated cone and fitting closely within the box. The rear end is closed by a plate (*e*, Fig. 2). Joined to this plate as an axis to the case is a hollow cylinder (*f*, Figs. 2, 6, and 7), with wound around it about 10 feet of wire, forming a coiled spring one end of which is secured to the cylinder, the other to the cartridge follower (*m*, Figs. 5 and 6).

The cut-off (*a b*, Fig. 8) fits at *a* and *b* into cuts in the forward end of the case; pressure on the thumb piece (*a*, Fig. 7) will then cause the entire case to rotate within the box, moving the mouth of the case (*e*, Figs. 5 and 8) from a position directly under the opening in the box at the bottom of the receiver (the adjustment for magazine fire) to another farther to the right, bringing the mouth of the magazine under the parts *b n*, Fig. 6, of the box, and preventing passage of the cartridges from the magazine to the receiver.

No. 33.—Larsen.

(Pl. xviii.)

This arm was submitted to the board by Mr. Ivert Larsen, of Chicago, Ill.

Its magazine holds five cartridges and has a cut-off.

In the plate, Fig. 1 shows the action open; Fig. 2, the action closed, and Fig. 3 is a section on A A, Fig. 1.

DESCRIPTION.

The mechanism is operated by a lever (*h*, Figs. 1 and 2) under the stock which above the neck (*f*, Figs. 1 and 2) of the handle merges into the parallel arms constituting the breechblock (*a* and *b*, Figs. 1 and 2; *s* and *t*, Fig. 3). These arms end in rivets, forming axles for two rolls (*e*, Figs. 1, 2, and 3), which traverse the well of the bolt. Between the arms is situated the piece (*p t*, Fig. 1), having in it a channel (*m n*, Figs. 1 and 2), through which passes a bolt (*n*, Fig. 1), terminating in the two arms of the block. The breech bolt contains the usual firing pin and spring, and in addition a separate striker and spring (*c*, Fig. 1).

The magazine is a detachable box secured in position by a spring catch (*d*, Figs. 1 and 2). The follower (*c*, Fig. 2) is a flat spring joined to the carrier (*l*, Fig. 2), which in turn is actuated by the tension of the spring (*s*, Fig. 2), acting on its shorter arm. This spring is kept in a

state of tension, differing from most magazine mainsprings, which are generally compressed.

The magazine can be cut off by sliding the box bodily down until the stud (*s*, Fig. 1) engages in the upper notch (*n*, Fig. 1) on the rear of the box.

The action being as shown in Fig. 2, pressure on the trigger will lower one and raise the upper arm (*a*, Fig. 2) of the sear lever, raising the corresponding arm of the sear and lowering and freeing the other arm from the notch in the firing pin. The pin will then plunge forward, impinging upon the head (*c*, Fig. 2) of the striker. The shock of discharge transmitted through the bolt and breechblock will be sustained by the surface (*a b*, Fig. 2) of the casing. Lowering the handle (*h*, Fig. 2), the bolt (*m*, Fig. 2) will pass along the channel (*m n*, Fig. 2), lowering the breechblock, separating its end (*a b*, Fig. 2) from the corresponding recoil shoulders of the casing, and draw back the breech bolt. At the same time the rolls (*e*, Fig. 1), traversing the well of the bolt force back the firing pin and compress its spring. The motion is limited by the projection (*k*, Fig. 1) of the block impinging against the recoil surface of the casing. Reversing the operation closes the bolt, the rolls pass on either side of the striker, and the engagement of the sear (*q*, Fig. 1) in the notch of the firing pin leaves its spring compressed.

The further details of construction and operation of the mechanism can be readily deduced from an examination of the drawing.

No. 34.—Miles.

This arm was submitted by Mr. Don D. Miles, of Aurora, Ill.

It had a tubular under-barrel magazine, holding nine cartridges, and was provided with a cut-off. Not enduring the earlier tests in a satisfactory manner, it was after a few minutes' trial withdrawn by the inventor for correction; but not being resubmitted no opportunity was afforded to prepare drawings or description.

No. 35.—Savage No. 1.

(Pl. xix.)

This arm was brought before the board by Mr. Arthur Savage, of Brooklyn, N. Y.

The magazine, cylindrical in shape, lies below the receiver; its full capacity is nine cartridges. There is no cut-off, but firing the upper cartridge from the magazine, replacing it, and so on a single-loader fire with eight cartridges in reserve can be maintained.

In the plate, Fig. 1 shows the action open; Fig. 2, the action closed.

Fig. 3 is a cross section of the magazine on A A, Fig. 1.

Figs. 4 and 5, cross section and side view of the magazine carrier.

Fig. 6, views of the magazine spring and spindle.

Fig. 7, a rear view of the breechblock.

Fig. 8, a side view of the magazine regulator and stop.

DESCRIPTION.

The mechanism is operated by the handle bar (*h*, Figs. 1 and 2), pivoted to the trigger guard (*g*, Figs. 1 and 2), and by the guide lever (*k*, Figs. 1 and 2), which passes within the casing and between the faces (*a*, Fig 7) at the rear of the breechblock. On the interior of the left face of the block is a channel (*a b*, Figs. 1 and 2) through which a lug (*a*, Figs. 1 and 2) at the end of the guide lever operates. In one piece with the block is the breech bolt (*m*, Fig. 1), containing the mainspring and firing pin and striker (*n*, Fig. 2).

The trigger (*t*, Figs. 1 and 2) is slotted at one end to embrace the stud (*s*, Fig. 1) on the rear; a shoulder (*c*, Fig. 1) on the block serves as a cocking piece and engages against a corresponding shoulder (*c*, Fig. 2) on the sear.

The sear is secured to the breech casing by the pivot (*w*, Fig. 1).

The extractor (*m*, Figs. 2 and 7) lies in a dovetailed groove on the upper surface of the breech bolt, to which it is secured by a pin (*p*, Fig. 2). The heel (*d*, Fig. 1) of the regulator acts as an ejector.

The magazine consists of a hollow spindle (Fig. 6, *d*, Fig. 2), which lies within the carrier (Figs. 4 and 5), the ends of the carrier serving as journals, which turn over the spindle.

Notches on the forward end of the spindle (*a*, Fig. 6) and a spring catch on the breech casing prevent movement of the spindle. The rear end of the spindle (*e*, Figs. 1 and 6) passes through and is supported by the breech casing. The magazine spring is fastened at one end (*b*, Fig. 6) to the spindle, at the other (*c*, Figs. 5 and 6) to the carrier; when given an initial tension it then tends to cause the carrier to revolve around the spindle. Around the carrier are two sets of teeth (*n*, Figs. 1, 4, and 5), which taken in pairs form grooves to contain the cartridges; the last of these pairs of teeth are made higher and are joined by a plate (*a*, Figs. 3, 4, and 5), to prevent cartridges falling back into the magazine as it is being emptied. The automatic regulator (Fig. 8, *d*, Fig. 1), by which the passage of cartridges from the magazine to the receiver is controlled, lies in a recess in the left face of the receiver, its projecting arm (*a*, Fig. 8) engaging over the shaft (*e*, Fig. 1) of the spindle, its lug (*e*, Figs. 2 and 8) closing the mouth of the magazine.

Presuming the piece to have been fired, the subsequent action is as follows:

Depressing the handle causes the guide lever (*k*, Fig. 2) and its lug (*a*, Fig. 2) to traverse the channel (*a*, Fig. 7) between the faces of the breechblock, first lowering and freeing the bolt from the recoil shoulders (*f*, Figs. 1 and 2) and then drawing the block and bolt to the rear, extracting the empty shell, and when its head reaches the shoulder (*d*, Figs. 1 and 8) on the regulator ejecting it. When the bolt is entirely back the spiral spring (*p*, Figs. 1, 3, and 8) back of the regulator throws it forward, depressing the stop (*e*, Figs. 2 and 8) and permitting the upper cartridge in the magazine (*b*, Fig. 3) to rise slightly in front of the bolt.

Raising the handle throws the breech block and bolt forward, and when the edge (*l*, Fig. 1) begins to bear in the channel between the faces of the block raises the bolt up in front of the locking shoulders. In this movement, after the shoulder (*c*, Figs. 1 and 7) abuts against the nose (*c*, Fig. 2) of the sear compression of the mainspring takes place. As the bolt pushes the cartridge into the chamber it also seats the regulator (*d p*, Fig. 1) in its recess in the receiver, causing the stop (*e*, Figs. 2 and 8) to rise and preventing the passage of a second cartridge from the magazine.

No. 36.—Mullins.

(Pl. xx.)

Tlris arm was submitted to the board by Mr. J. W. Mullins, of Faris ton, Ky.

The gun has no cut-off. The magazine is placed below the receiver and has a working capacity of three cartridges; it will contain more, but if they are put in the magazine the mechanism can not be operated.

In the plate, Fig. 1 is a longitudinal section with the action open; Fig. 2, a similar section with action closed.

Fig. 3 is a cross section on A A, Fig. 1; Fig. 4, a section on B B, Fig. 3.

DESCRIPTION.

The breechblock (*a*, Fig. 1) is essentially that of the Springfield system, the only changes being to narrow down the part (*a*, Figs. 1 and 4) that enters the well of the receiver and the introduction of a flat spring (*c*, Figs. 1 and 2) that impinges against the lug (*d*, Fig. 2) of the extractor when the block is thrown fully back, and of a pin (*e*, Figs. 1 and 2) on which is pivoted the magazine lever (*b*, Figs. 1 and 2).

The cam and latch, extractor, ejector, sear, trigger, hammer, etc., are those used on the present service Springfield.

The magazine placed between and below the walls (*b b*, Fig. 4) of the receiver is a tin box (*a d*, Fig. 4), secured to the lower part of the stock, which is shaped out to receive it by two screws (*a*, Fig. 2). Pivoted to the front (*e*, Figs. 1 and 2) of the breechblock is the magazine lever (*b*, Figs. 1 and 2), to which at its other end (*n*, Figs. 1, 2, and 4) is attached the hand or spoon (*m n p*, Figs. 1 and 2), the latter also being secured by the fixed pivot (*o*, Figs. 1, 2, and 4) to the right-hand wall of the receiver. The spoon is provided with a bearing guide (*p*, Figs. 1 and 2) to keep it at the proper distance without the box, outside of which both lever and spoon move.

Operating between the sides of the box the follower (*f*, Figs. 1, 2, and 4), pivoted at its forward end (*h*, Figs. 1, 2, and 3), tends under the influence of the magazine spring (*s*, Figs. 1 and 2) to lift the cartridges to the level of the chamber.

Presuming the gun to have been fired, the mechanism, except the hammer, will be as shown in Fig. 2. Lifting the block the empty shell will be extracted as in the Springfield and ejected when it reaches the bowl of the spoon, which meanwhile will have risen to the position given in Fig. 1. As the block opens the end (*e*, Fig. 1) of the magazine lever rises, moving the other end (*n*, Fig. 2) to the front and upwards, and causing the spoon to rotate about its bearing (*o*, Figs. 2 and 4) in the receiver from the position shown in Fig. 2 to that given in Fig. 1.

As the block is closed the magazine lever will reverse the rotation of the spoon, and the follower having raised the cartridges the bowl of the spoon (*m*, Fig. 1) will drive the upper cartridge into the chamber, while the spring (*t*, Fig. 2) being liberated its hook will advance ready to retain the succeeding cartridge until the preceding empty shell has been ejected.

No. 37.—Chaffee-Reece.

(Pl. xxiii.)

This arm was submitted by the Chaffee-Reece Arms Company, of Washington, D. C.

The magazine, holding five cartridges, is tubular and is situated in the butt stock. There is a cut-off.

The arm in the principle of its mechanism and the details of its construction is exactly similar to the Chaffee-Reece gun No. 33, of caliber .45, tested by the Board on Magazine Guns of 1881–'82 and described, with record of its test, in their report, pp. 93 to 95 and Pl. XV. This report also appears as Appendix 30 of the Report of the Chief of Ordnance for 1882.

The only alterations in the arm before the present board are those necessitated by the change in the size of some of the parts in consequence of the reduction to .30 in the caliber.

No 38.—Blake No. 1.

(Pl. XXI.)

This arm was submitted to the board by Mr. John H. Blake, of New York City.

The magazine, lying below the receiver, contains a revolving cylindrical packet holding seven cartridges. This packet is essential to the operation of the arm as a magazine gun. There is a cut-off.

In the plate, Fig. 1 shows the action open; Fig. 2, action closed in firing position.

Fig. 3 is a plan view of bolt in firing position; Fig. 4, a cross section on A A, Fig. 3 showing connection of extractor stud with bolt.

Figs. 5 and 6, cross sections on A A, Fig. 1, the former with the cartridge packet adjusted for magazine fire, the latter with the magazine in reserve.

Fig. 7 is a rear view of the cartridge packet, showing shoulders for the engagement of the cylinder hand and the holes for the cylinder bolt stop.

DESCRIPTION.

The receiver has on its left-hand side a broad and deep groove (*a*, Figs. 1, 5, and 6) for the passage of the left locking lug (*a*, Figs. 2 and 3) of the bolt, and on the right a shoulder (*c*, Figs. 5 and 6) for the extractor (*b*, Fig. 3) and right locking lug (*c*, Figs. 2 and 3) of the bolt. The entire bottom is cut away (*b*, Figs. 5 and 6) to permit the upward and forward movement of cartridges from the magazine. The forward breech casing contains the grooves for the locking lugs of the bolt, and on the right hand a cut for the hook of the extractor. At the rear the breech casing for a short distance is closed at the top (*f*, Fig. 1), completely encircling the bolt; back of that a channel is left for the passage of the handle, while at the right a shoulder is formed, in front of which the base of the handle locks in the firing position.

The bolt consists of the body, the cocking piece and sleeve, the firing pin and spring, and the extractor. The well of the body, except where closed for the striker (*e*, Figs. 1 and 2), is bored of one diameter. Near the front of the body are the two locking lugs (*a* and *c*, Fig. 3), the right-hand one having a shoulder against which the extractor rests as the bolt is moved back and forth; on top and on the right of the body is an opening (*d*, Figs. 1, 3, and 4), through which a lug (*d*, Fig. 3), on the under side of the extractor, passing through a corresponding cut in the

sleeve (*c*, Fig. 4), bears against a flattened portion of the shank of the firing pin. On the left of the body is a stud (*e*, Fig. 3), which, as the bolt is pushed forward, impinges against the operating arm (*m*, Fig. 1) of the magazine, moving it forward and thereby lowering the cylinder hand (*n*, Figs. 1 and 2) from the position in Fig. 1 to that in Fig. 2, ready, as the hand is later raised, to rotate the cartridge packet. On the rear end of the bolt is the usual cam (*f*, Fig. 3) for forcing back the cocking piece as the handle is turned up to the left. The cocking piece (*b d*, Fig. 2, *m*, Fig. 3) screws on to the end of the firing pin; it contains the notch for the nose of the sear (*p*, Fig. 2) and on its upper surface the nose (*m*, Fig. 3), which acts on the cam (*f*, Fig. 3), as above mentioned.

The sleeve has a tang (*h*, Fig. 1), which enters a fork (*k*, Fig. 1) in the forward end of the cocking piece; through a cut (*l*, Fig. 1) the stud (*d*, Fig. 4) on the under side of the extractor bears against the firing pin. The firing pin and striker are in one piece; the shoulder of the striker and the front face of the sleeve form the two bearings for the mainspring.

The extractor consists of the hook and body. The hook (*b c*, Fig. 3) rests between shoulders of the body, to which it is secured by a stud; the body is attached to the bolt by the lug (*d*, Figs. 3 and 4), which passes through cuts made for that purpose in the bolt body and sleeve.

The ejector (*p*, Fig. 1) is pivoted on the left part of the breech casing; a spring bears against its lower surface.

The magazine casing consists of a cylindrical box (*p q*, Fig. 2, *d e f*, Figs. 5 and 6) placed below the receiver. Its bottom is hinged at the left side (*d*, Figs. 5 and 6), and when closed is secured by the catch (*e f*, Figs. 5 and 6). The cartridge packet (Fig. 7, *r s*, Fig. 2) has at the front and rear ends (*m*, Fig. 7) trunnions, which rest in beds in the front and rear faces of the casing (*t*, Fig. 2). The rear of the packet has shoulders (*b*, Fig. 7), where the hand (*u*, Fig. 2) engages, and holes (*c*, Fig. 7) in which the point of the cylinder stop (*h*, Fig. 2) enters to limit the rotation of the packet. The cartridges are placed on the beds (*r s*, Fig. 2).

The operating arm of the cut-off is on the left of the stock opposite the bolt handle; from it a stud engages on the lower part of the arm (*m*, Figs. 1 and 2), and when single-loading fire only is desired can so depress the arm that the lug and stud (*a* and *r*, Fig. 3) of the bolt will pass over without operating it.

If it is desired to load the magazine and hold it in reserve, the bolt must first be closed, then, opening the casing, placing the packet with its trunnions in their beds, and closing the casing smartly, the packet will be forced to take the position shown in Fig. 6. Then, with magazine cut-off, single-loader fire can be delivered. If the casing is closed when the bolt is withdrawn, it may, when closed, take the position shown in Fig. 5, a cartridge lying directly in front of the bolthead.

Presuming the piece to have been fired, turning up the handle throws, in consequence of the cam (*f*, Fig. 3) and nose (*m*, Fig. 3), the cocking piece, and therefore the firing pin, to the rear; but as the stud (*d*, Figs. 3 and 4) on the extractor passing through the body and sleeve prevents the latter from traversing the well of the former, the rear bearing of the mainspring does not change its position, and as the striker is drawn back the space for the mainspring is lessened, thus compressing it. When the upward motion of the handle is a little over half completed, its base, by the inclined surface of the shoulder of the breech casing, is moved slowly back, starting the bolt to the

rear and loosening the empty shell. After rotation is completed, as soon as the bolt is drawn back, the notch (*c*, Fig. 1) passes the nose of the sear; when almost fully back the locking lug (*a*, Fig. 3) abuts against the arm (*m*, Fig. 2), revolving it back, withdrawing the cylinder stop (*h*, Fig. 2) from its engagement in the rear (*c*, Fig. 7) of the packet and lifting the cylinder hand (*n*, Fig. 2) causes, by the latter's bearing against a shoulder (*b*, Fig. 7) of the packet, a one-seventh revolution of the cylinder, bringing a second cartridge (*m*, Fig. 5) into the bottom of the receiver in front of the bolt.

Reversing the movement of the bolt, the stud (*e*, Fig. 3) meets the arm (*m*, Fig. 1), moves it forward, and lowers the hand (*n*, Fig. 1) until it engages below a second of the shoulders (*b*, Fig. 7) on the cylinder packet. As this motion is completed the cocking piece is stopped by the nose of the sear, and as the handle is turned down to the right the firing pin and striker are held while the sleeve and body of the bolt moving slightly forward the mainspring space is lessened, this time from the rear, completing its compression.

At the same time the cartridge is pushed fully into the chamber and the recoil or locking lugs (*a* and *c*, Figs. 2 and 3) seated in front of the shoulders (*b*, Fig. 1) in the casing.

The piece can not be fired unless fully locked, for as the trigger is pulled the nose (*p*, Fig. 2) of the sear can not leave the notch until the arm (*f*, Fig. 2), of which it forms a part, rises into a narrow cut provided on the lower side of the bolt for that purpose.

A friction spring (*w*, Fig. 2) is introduced in the bottom of the cover of the magazine casing to control the revolution of the packet and prevent, in connection with the stop bolt (*h*, Fig. 2), the cylinder throwing past when the mechanism is rapidly manipulated.

No. 39.—Lee No. 3.

This arm was submitted by the Lee Arms Company, of South Windham, Conn.

It is similar to the Lee No. 1 (No. 25 on list of arms before the board), only so differing in the arrangement of such of the minor parts as the inventors deemed necessary to overcome the difficulties experienced in the test of the first gun.

No. 40.—Hampden No. 2.

(Pl. xvi.)

This arm was submitted by Mr. Thomas B. Wilson, of Springfield, Mass.

Hampden No. 1 (No. 31 on list of arms before the board) is identical with it, except that in No. 2 certain feed springs are introduced into the magazine which were omitted in No. 1.

The capacity of the magazine is five cartridges. The gun has a cut-off.

In the plates, Figs. 1 and 2 are longitudinal sections, the former showing the action open, the latter the action closed ready for firing.

Fig. 3 is a section on A A, Fig. 1, showing the receiver and the cartridge packet in position.

Fig. 4 is a section on B B, Fig. 1, showing the cam for the locking lug and recess for extractor hook.

Fig. 5 is a section on C C, Fig. 2, showing the extractor, the guide-ways of the breech casing, and the cocking piece.

Fig. 6 is a section of D D, Fig. 2, showing the extractor and locking lug in firing position.

Fig. 7 is a plan view of the bolt, the mechanism being as given in Fig. 1.

Fig. 8, rear view of bolt showing cocking cam.

Fig. 9, side view of extractor.

DESCRIPTION.

The arm possesses the peculiarity that the magazine mechanism, including the cut-off, is entirely contained in the cartridge packet, which is placed in a receptacle to the left and above the receiver; the construction of the latter is thereby made very simple.

It is cut away at the right side, leaving a straight shoulder (*a*, Figs. 1 and 3), upon which the long guide and locking rib (*b*, Fig. 1) of the bolt rests when ready for firing. Next this shoulder the bottom of the receiver (*c*, Fig. 3) is slightly curved to conform to the shape of the bolt, and the other half of the bottom is cut (*d*, Fig. 3) at an abrupt shoulder, forming a pocket for the first cartridge from the magazine. Above this pocket a straight rail (*f*, Figs. 1 and 3) closes the left side of the receiver proper. Between this rail and the bottom of the pocket is the passage (Fig. 3) for the movement of cartridges from the magazine. Back of the receiver the right side (*e*, Fig. 5) of the breech casing rises to the level of the left rail (*f*, Fig. 5) of the receiver, forming with it a channel for the passage of the extractor body (*d*, Figs. 1, 2, and 5) and the guide rib (*b*, Fig. 1) on the bolt. Below this in the casing is a socket (*c*, Figs. 1 and 2) for the ejector and in the tang a channel (*e*, Figs. 1 and 2) for the passage of the nose of the cocking piece (*h*, Figs. 1 and 2). Forward in the casing is a cut for the hook (*a*, Figs. 2, 4, and 6) of the extractor, a cam way (*f*, Figs. 4 and 6) to direct the movement of the locking lug (*b*, Figs. 6 and 7) and a recess (*k*, Figs. 1, 2, and 4), which it enters when locked. Gas ports (*m*, Fig. 1) are provided in the breech casing.

The bolt (Fig. 7) consists of the body, with its guide rib (*b*, Fig. 1), operating handle (*f*, Fig. 7), and locking lug (*b*, Fig. 7) of the firing pin (*f*, Fig. 2) and cocking piece (*h*, Fig. 2), which are in one, and of the firing-pin sleeve (*n*, Figs. 1 and 7).

The well of the body is bored of one dimension, except as closed at the front, for the passage of the striker (*b*, Fig. 2). At the rear of the body is the cam (*a*, Figs. 7 and 8) for throwing back the cocking piece, and a notch (*c*, Figs. 7 and 8) for retaining it as the bolt is drawn back. This cam is made in a reënforced portion of the bolt (*p*, Figs. 1 and 7), whose forward shoulder is under cut for the retaining hook (*b*, Fig. 9) of the extractor.

The firing pin consists of the straight body terminated at the rear in the cocking piece (*h*, Figs. 1, 2, and 7). This cocking piece has the full and half cock notches on its lower side (*h*, Fig. 1) and on its upper a guide rib (*b*, Figs. 1 and 2), which enters a slot (*e*, Fig. 7) in the sleeve. At the forward end (*n*, Fig. 2) the pin enters a socket joint in the striker (*b*, Fig. 2). The sleeve (*n*, Figs. 1 and 7) moves on the firing pin and is forked at the rear (*e*, Fig. 7) to slide over the cocking piece. It is retained in position by the hooks (*s*, Figs. 1 and 2), which

engage upon the rear hook (*c*, Fig. 9) of the extractor. The forward end (*m*, Fig. 2) of the sleeve and the rear end (*n*, Fig. 2) of the striker give the two bearing surfaces for the main spring.

The extractor (Fig. 9, *d*, Figs. 1 and 2) by its hooks (*b* and *c*, Fig. 9) engaging over the body of the bolt and the sleeve assembles the parts of the bolt; it is composed of the body (*d*, Fig. 1) and of the extractor proper (*a*, Figs. 2 and 9), which is secured in a socket in the forward end of the body by its lug (*t*, Fig. 1) and a retaining pin.

The ejector (*c*, Figs. 1 and 2) is a curved spring with a stud (*w*, Fig. 1), projecting through into the bottom of the receiver; the stud rises as a slot in the head of the bolt and passes over it.

The sear is of rather novel design, but its operation with that of the trigger is sufficiently indicated by the drawing (Figs. 1 and 2).

The magazine is simply a receptacle (*d e f*, Fig. 3) to the left and above the receiver into which the cartridge packet is slid, where it is retained by a rib on the side of the packet entering a short, narrow slot (*e*, Fig. 3) in the left wall.

The cartridge packet is a case, closed except at the bottom (as placed in position). At the top is a folded leaf spring (*y*, Fig. 1) one end secured under a cross-bar (*r*, Fig. 1), the other being free and acting as a follower. The action of this spring being assisted by the weight of the cartridges great stiffness is not required.

The cut-off (*g*, Figs. 1, 2, and 3) is a flat piece of spring steel sliding within the socket (*i*, Figs. 1, 2, and 3) and moved by the curved thumb piece (*x*, Figs. 1, 2, and 3). Its upward motion is limited by a stud (*i*, Fig. 2), its downward by the thumb piece (*x*, Fig. 2). When raised it permits the cartridges to issue freely from the packet until the lower one enters the pocket (*d*, Fig. 3) in the receiver; lowered it projects beyond the mouth of the packet and retains the cartridges therein.

Presuming the piece to have been fired: As the bolt handle is turned up, the cocking piece being engaged in the groove in the tang is prevented from turning, and consequently by the cam on the rear end of the bolt is forced back, partly compressing the mainspring. When the upward motion of the handle is nearly completed, its base bearing against the right shoulder of the breech casing and the locking lug bearing in the cam (*f*, Fig. 6), the entire bolt is moved slowly to the rear, starting the empty shell; during this preliminary extraction the compression of the mainspring is continued, the nose of the cocking piece entering finally the notch (*c* Figs. 7 and 8) at the end of the bolt. Now, drawing back the bolt, the full-cock notch immediately passes the nose of the sear; the extraction of the shell will be continued, and when its head meets the ejector will be thrown out of the receiver. Motion of the bolt to the rear is limited by the locking lug abutting against the forward part of the right shoulder (*e*, Fig. 5) of the breech casing.

As the bolt passes the mouth of the magazine the lower cartridge, which until then it has sustained, will fully enter the pocket (*d*, Fig. 3) in the receiver, its head just sufficiently (Fig. 3) above the floor of the receiver to be in front of the bolt. Returning the bolt this cartridge is driven forward into the chamber, and the mouth of the magazine closed to a second cartridge by the bolt itself. When the base of the handle reaches the rear part of the right shoulder of the breech casing its further direct motion is stopped; just before that moment the sear again engages on the full-cock notch.

Turning down the handle the locking lug enters its recess, and the

bolt moving slightly forward the mainspring is still further compressed as the cartridge is fully seated.

The piece can be cocked as described, or by turning up the handle, very slightly withdrawing the bolt and returning it to its firing position; or the cocking piece, grasped through the ring at its end, can be drawn back directly.

There is no safety lock, but the cocking piece can be let down until the sear engages in the half-cock notch (*h*, Fig. 1); or the same engagement can be obtained by (after loading) partly turning up the bolt-handle and then returning it to the firing position.

From the position and form of the cartridge packet, by simply using larger packets, a greater number than five cartridges can be introduced into the magazine, the number being limited only by the convenience of handling the packets and the amount of projection above the gun which it is desired not to exceed.

No. 41.—Russell-Livermore No. 1.

(Pl. xxii.)

This gun was submitted to the board by Maj. W. R. Livermore, Corps of Engineers, U. S. Army, and Capt. A. H. Russell, Ordnance Department, U. S. Army.

The barrel and breech bolt are the same as on the Lee-Speed of England (Pl. i), and the arm is adapted to that cartridge. The receiver in all essential features is also the same.

On this gun the magazine of Maj. Livermore and Capt. Russell has been substituted for that of the Lee pattern.

The gun has a cut-off identical with the Lee-Speed.

In the plate, Fig. 1 is a longitudinal section of the magazine and receiver.

Fig. 2, a side view of the same.

Fig. 3, a side view of the loading packet.

Fig. 4, a section of magazine box and carrier lever on A A, Fig. 1.

DESCRIPTION.

The magazine box is retained in the frame by a catch (*a*, Figs. 1 and 2), which acts as in the Lee-Speed; the trigger part (*d*, Figs. 1 and 2) of this catch is, however, so shortened as not to protrude within the guard, and can, therefore, not be accidentally operated.

An addition, the stock (*b*, Figs. 1 and 2) overlaps the bottom of the box and assists in retaining it in place. On the right side of the box a rib (*c*, Figs. 2 and 4) gives the box a bearing upon the inside of the stock, which has been cut away to permit action of the arm (*e*, Figs. 1 and 2) of the carrier lever. A portion (*c*, Fig. 1) of the bottom of the box is open to permit passage through it of the loading packet (Fig. 3), and a part of the sides of the box are cut away (*h*, Fig. 2) to allow the fingers to grasp the packet, which is roughened (*b*, Fig. 3) to afford a surer hold when drawing it from the box. Near the front of the box a channel (*f f*, Fig. 2) is made, in which the short arm (*m*, Figs. 1 and 2) joining the follower (*n*, Figs. 1 and 2) to the lever (*e*, Figs. 1 and 2) moves.

Secured by rivets (*p*, Figs. 1 and 2) to the right base is a sleeve (*p*

p k, Figs. 1 and 2) embracing the sides and bottom of the barrel and affording at its right side the support for the carrier lever. This lever (*n m e*, Figs. 1 and 2) is composed of the long arm (*e*, Figs. 1 and 2), pivoted by a screw (*t*, Figs. 1 and 2) to the sleeve of the follower portion (*n*, Figs. 1 and 2) and of the connecting arm (*m*, Figs. 1 and 2); these parts are all in one piece. Acting on the heel of the lever is the magazine spring (*w*, Figs. 1 and 2). The stud (*s*, Figs. 1 and 2) limits in both directions the motion of the lever.

The magazine mechanism operates as follows: The packet (Fig. 3) having been loaded, the points (*a a*, Fig. 3) are bent over the cartridges to secure them in the packet.

Introducing the packet through the receiver into the rear part of the magazine box it lowers the lever, compressing the magazine spring (*w*, Figs. 1 and 2). The packet is then grasped from below by the thumb and finger and pulled through the box, entirely withdrawing it from the magazine, in which, through the intervention of the follower portion (*w*, Figs. 1 and 2) of the lever, the cartridges are retained. Flat springs (*x*, Figs. 1 and 2) on either side of the receiver project over the upper cartridge and prevent it rising too far into the receiver. Closing the bolt, this first cartridge is pushed into the chamber, the remainder being lifted by the lever until the upper one rests against the under side of the bolt, in front of which it in turn rises as the bolt is entirely withdrawn.

No. 42.—Russell-Livermore No. 2.

(Pl. xxii.)

This arm was submitted to the board by Maj. W. R. Livermore, Corps of Engineers, U. S. Army, and Capt. A. H. Russell, Ordnance Department, U. S. Army.

The barrel and breech bolt are the same as the Lee-Speed of England (Pl. i), and the arm is adapted to that cartridge, the English magazine being removed and the receiver modified as far as necessary to conform to the Russell-Livermore magazine.

The magazine can be cut off.

In the plate, Fig. 1 is a plan view and horizontal section of the magazine.

Fig. 2, side view and vertical section of magazine.

Fig. 3, cross section of magazine on A A, Fig. 1.

DESCRIPTION.

The greater part of the floor (*a*, Figs. 1 and 3) of the magazine is flat; having, however, two curved grooves (*b* and *c*, Fig. 2), one forming a channel in which the heads of the cartridges move in the magazine as they approach the bolt, and the other affording freedom for the action of the follower and with its shoulder near the chamber keeping up the points of the bullets. The rear wall (*d*, Figs. 1 and 2) is curved and with the front face (*c*, Fig. 1) so directs the movement of the cartridges that the head of one is always in advance of the head of the succeeding. On the left the magazine merges into the left wall (*e*, Fig. 3) of the receiver; on the right side it projects considerably (Fig. 1) beyond the stock on the floor (*a*, Fig. 3) to a greater distance than the top (*b*, Fig. 3),

thus leaving an opening (*d*, Figs. 1 and 3) through which cartridges can be introduced when the lever (*n*, Figs. 1 and 3) and the follower (*f*, Figs. 1 and 3) are retracted. The right-hand guide rail (*e*, Fig. 3) of the receiver protrudes slightly over the top of the magazine.

The carrier lever (*n w*, Fig. 1) is pivoted to the frame by a screw (*p*, Figs. 1 and 2); the magazine spring (*e*, Fig. 1) acting on the heel (*b*, Fig. 1) of the lever tends to carry it and the follower forward into the magazine. The lever terminates in a plate (*h*, Figs. 1 and 2) shaped to the ends of the fingers, by which, when pressure is given, the lever and follower are retracted to the position shown in Figs. 1 and 3, leaving free the opening (*d*, Figs. 1 and 3) of the magazine.

The follower (*f*, Figs. 1, 2, and 3) is by the rivet (*m*, Figs. 2 and 3) pivoted to the lever; it is so shaped as to bear against the body (*f*, Fig. 1) of the cartridge and also upon the bullet (*c*, Fig. 1).

The cut-off is pivoted back of the left wall of the receiver, beyond which its thumb piece (*t*, Fig. 1) lies.

The blade (*r*, Fig. 1) is also outside the receiver when arranged for magazine fire.

To cut off the magazine, the thumb piece is moved forward (*w*, Fig. 1), throwing the blade (*s*, Fig. 1) over the first cartridge in the magazine.

It can be operated with the magazine either empty or full and with the bolt either closed or open.

No. 43.—Savage No. 2.

This arm was submitted by Mr. Arthur Savage, of Brooklyn, N. Y.

It is identical with the Savage No. 1 (No. 35 on list of arms before the board) except that the breechblock broken in the test of that gun had been strengthened.

No. 44.—Fogerty.

This gun was submitted by Mr. George Fogerty, of Cambridgeport, Mass.

The magazine is tubular in the butt stock and is charged through a gate on the right-hand side. Its capacity is six cartridges; there is a cut-off. An oscillating jointed carrier, having also a vertical motion, is actuated by the breech bolt and lifts the cartridges as they are delivered from the magazine up into the receiver.

The gun very early in the test developing radical defects of design as well as workmanship, neither drawings nor an extended description are here given.

No. 45.—Durst No. 2.

This gun differs in no essential particulars from the Durst No. 1 (No. 32 in list of guns before the board), previously described and illustrated. (See Pl. xvii.)

No. 46.—Mauser No. 5.

(Pl. xv.)

This arm was submitted by Mr. Alfons Mauser, of Hartford, Conn.

It is very similar to the Mauser No. 3 (No. 24 in the list of guns before the board), the only change about the bolt being that the portion of the extractor between the parts *m* and *e* (Fig. 7, Pl. xv) back of the locking lug (*c*, Fig. 4) is slightly beveled out and lightened.

The magazine is a combination of that in the Mausers No. 3 and No. 4. The follower, lever, spring, etc., are as shown in Fig. 10. The magazine box itself is fixed, but within it is a second skeleton box having only a back and sides, the latter with the overturned lips shown in Pl. xv (*a*, Fig. 9); on the back of the auxiliary box, instead of the ratchet (*a*, Fig. 1) is a single cylindrical groove with shoulders above and below. The cut-off lever, instead of the cogs on its arbor (*c*, Fig. 3), has a single lug, which, bearing against these shoulders, lowers or raises the auxiliary box as the thumb piece of the cut-off is lowered or raised.

No. 47.—Blake No. 2.

This gun is the same as the Blake No. 1 (No. 38 in list of guns before the board), which developing some defects on its first trial was withdrawn by the inventor for correction.

The arm has been previously described and is illustrated in Pl. xxi.

No. 48.—Rubin (Swiss).

This arm, submitted to the board by the Chief of Ordnance, U. S. Army, is fully described in the report of the Chief of Ordnance for 1889 in the proceedings of a board of ordnance officers, who that year subjected it to exhaustive trial.

No. 49.—Schulhof, Model 1888.

This arm, submitted to the board by the Chief of Ordnance, U. S. Army, is fully described in the report of the Chief of Ordnance for 1889 in the proceedings of a board of ordnance officers, who that year subjected it to exhaustive trial.

No. 50.—Kelton.

This arm was submitted to the board by Gen. J. C. Kelton, Adjutant-General, through the Chief of Ordnance, U. S. Army.

The caliber was .45 and it was adapted to the present army service cartridge (70 grains black powder, 500 grains bullet). It is not a magazine arm, but carries underneath the stock just in front of the trigger guard, as a quick-loading device, a wooden block bored to receive ten cartridges.

In appearance like the Springfield, the breechblock is modified to contain a spring which, by the action a hinged lever, is compressed as the block is opened.

The cam is the same as in the Springfield gun.

No. 51.—Springfield No. 1.

This gun, though a single loader, was submitted that comparisons between it and the magazine arms before the board might be instituted. The caliber was .30.

In all essential features the gun is the same as the caliber .45 Springfield now in service; the exceptions being merely such changes as are made necessary by the reduction of caliber, and a modification in the cam and shaft by which, in addition to its former motion of rotation as the latch is lifted, it is also given a motion of translation at right angles to the axis of the receiver.

The new cam more securely locks the breechblock under the shock of discharge and also facilitates its opening afterwards.

No. 52.—Springfield No. 2.

This arm differs from the Springfield No. 1 (No. 51 in list of guns before the board) in the following particulars:

The well of the receiver is slightly and gradually deepened from the rear of the ejector stud to the seat of the breech screw, and it has also a small vertical cut at its forward end under the counterbore; these two changes were made to afford space for the unburnt powder grains and to facilitate their removal.

The extractor is altered so that its bearing surface on the cartridge head is much increased.

Externally the receiver no longer tapers from rear to front, but is made straight; this thickens and strengthens the gun over the chamber, also strengthens the ears and affords better support to the extractor.

No. 53.—Springfield No. 3.

This arm differs from the Springfield No. 2 (No. 52 in list of guns before the board) merely in the omission of the vertical cut in the receiver under the counterbore, which was originally designed as a receptacle for fouling and unburnt powder grains.

PART III.—*Synopsis of tests of guns.*

Programme of the tests prescribed by the board for trial of guns submitted will be found in the proceedings for December 17, 1890.

In the application of these tests, that for safety was fired either by the inventor or in his absence, when the gun was not well known, with a lanyard from a fixed rest. In other cases the safety test was fired by the recorder of the board.

For this test all guns were used as single loaders only, the cartridges being conveniently disposed upon a table near the operator.

The tests for rapidity with accuracy and rapidity at will were fired by the recorder and by Mr. R. T. Hare, an employé of the Springfield Armory, the cartridges for the firing being conveniently arranged upon a table placed at the side of the operator.

In the remainder of the regular tests the firing was conducted from a fixed rest.

In the supplementary tests the guns were fired from a fixed rest.

In the additional tests given a few guns the firing was done by enlisted men of the ordnance detachment at the Springfield Armory, the arms being loaded from the cartridge belt.

NO. 1.—LEE-SPEED (ENGLAND).

NOTE.—Before the Board on Magazine Arms was convened this gun had been fired 260 times at the National Armory under direction of an officer, afterwards recorder of this board, testing initial velocity, accuracy at ranges from 200 to 1,000 yards, and rapidity. As appears from the report of the trial, the magazine spring was broken during the firing and replaced by "a new spring exactly similar to the old one."

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder 10 shots in 30 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 8 cartridges, 12 shots were fired as a single loader; time, 32 seconds; the cut-off was then opened, throwing the magazine on, and the 8 shots fired; time, 17 seconds; total time for the 20 shots, 49 seconds; 18 hits.

(*b*) *As single loader for 2 minutes.*—Forty-nine shots were fired, making 39 hits.

(*c*) *As magazine arm for 2 minutes.*—Magazine loaded three times with cartridges pressed in one by one; operation slow and troublesome and considerable force required to push in the last one or two. Seventeen shots were fired with 16 hits and 7 cartridges left in magazine.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Time, 27 seconds for 12 shots as single loader and 11 seconds more for the 8 cartridges in magazine. Total time for the 20 shots, 38 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-eight shots were fired.

(*c*) *As magazine arm for 1 minute.*—Magazine loaded twice, same difficulty being experienced as in test 1, *c*. Eleven shots were fired, leaving 5 cartridges in magazine.

III. ENDURANCE.

(*a*) *As magazine arm for 500 rounds.*—Magazine spring broke on one hundred and eighty-eighth shot; replaced by new spring and test continued. On the four hundred and ninetieth shot one of the clips by which the platform is secured to the carrier broke off, and the other clip was discovered to be weakened; both clips replaced by new ones and test concluded. After about the first half of the test as the gun heated the bolt commenced to work stiffly and toward the close was turned with great difficulty. The bolthead screw worked loose.

(*b*) *As single loader for 100 rounds.*—Bolt opened stiffly; near close of test could only be turned by using both hands or by giving light blows with a mallet. Bolthead screw loose.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Bolt worked stiffly.

(*b*) *Magazine loaded when exposed.*—Well dusted. Bolt worked stiffly and after each shot was turned with difficulty. Cartridges frequently not brought up from magazine, the carrier being retained by friction against sides of box.

V. DEFECTIVE CARTRIDGES.

No. 1. Slight escape of gas, extraction easy.

No. 2. Liberal escape of gas, extractor spring broken and hook of extractor slipped over cartridge head without extracting. Magazine cartridge carrier forced to bottom of box compressing spring and caught against side of magazine.

No. 3. No escape of gas.

VI. EXCESSIVE CHARGES.

Maxim smokeless powder used in cartridges. Bolt opened stiffly. Extractor spring not having been replaced, the empty shell had to be removed by hand.

VII. EASE OF MANIPULATION.

Satisfactory to the board.

No. 2.—Krag-Jörgensen No. 1 (Denmark).

NOTE.—Before the Board on Magazine Arms was convened this gun had been fired 240 times at the National Armory under direction of an officer, afterwards recorder of this board, testing initial velocity, accuracy at ranges from 200 to 1,000 yards, and rapidity. As appears from the report of the trial the gun endured all these tests well.

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 45 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were first fired as a single loader. In the first trial after the tenth shot the operator's sleeve caught on the thumb piece of the magazine latch, partly opening the gate of the magazine, thereby removing the pressure of the follower or feed plate from the single cartridge then left in magazine, which consequently was not fed into the receiver. On the second trial the 15 shots were fired as single loader in 44 seconds, the 5 in the magazine in 11 seconds. Total time for the 20 shots, 55 seconds; 18 hits.

(*b*) *As single loader for 2 minutes.*—Forty-two shots were fired, making 37 hits.

(*c*) *As magazine arm for 2 minutes.*—After 14 shots had been fired in 40 seconds the next cartridge, the last then in magazine, was wedged (as the bolt was being closed) between the head of the bolt and the right side of the shoulder, formed by the junction of barrel and receiver, the point of the bullet, being directed too far to the right, not passing into the chamber. By slightly withdrawing the bolt the cartridge could be freed and dropped into receiver, and was then readily pushed into the chamber.

Entirely repeating the test 35 shots were fired, with 24 hits; 5 cartridges (its capacity) were left in magazine. In this test the magazine was charged from an ammunition case of sheet metal, holding 5 cartridges, by which that number were introduced in one motion.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Time, 29 seconds for 15 shots and 6 seconds more for 4 shots from magazine. The fifth cartridge (the last from the magazine) jammed against the rear face of chamber without entering it, as in preceding test.

Repeating the trial, 15 shots were fired as single loader in 30 seconds, the 5 in magazine in 7 seconds; total time for the 20 shots, 37 seconds.

(*b*) *As single loader for one minute.*—Twenty-eight shots were fired. During the firing the magazine latch was, as in previous case, hit by operator's hand or sleeve and gate partly opened.

(*c*) *As magazine arm for one minute.*—After 19 shots had been fired in 48 seconds, the twentieth cartridge, the last then in magazine, caught against face of chamber instead of entering.

Repeating the test, the fifth cartridge, the last then in magazine, caught as before. Again repeating, the test was successfully concluded, 25 shots being fired and magazine charged with five more cartridges.

III. ENDURANCE.

(*a*) *As magazine arm for 500 rounds.*—Ejector spring broke after fifth shot; it was replaced by new spring and test concluded, gun working easily. During this test it was observed that if the magazine was loaded by hand there was a liability of the cartridges being placed in the magazine with the bullets further to the left and the cartridges further removed from parallelism to the axis of the bore than when the ammunition case was used. This would raise unduly the bullet of the first cartridge, while permitting the head to slightly fall, and when motion was made to close the bolt would result in a jam caused by the body of the shell about its center wedging against the points at the right and left of the middle portion of the magazine slot in the receiver. When the magazine gate was opened this wedged cartridge could be forced back into the magazine and the cartridges straightened, when they would feed properly. This jam did not occur when the magazine was loaded from the ammunition case.

(*b*) *As single loader for 100 rounds.*—Gun worked well and easily.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Mechanism thoroughly dusted; gun worked freely.

(*b*) *Magazine loaded when exposed.*—Well dusted; bolt opened a little stiffly, but worked well.

V. DEFECTIVE CARTRIDGES.

No injury whatever to mechanism from the three forms of defectives; gun worked well.

VI. EXCESSIVE CHARGES.

Bolt opened easily; mechanism worked freely and well.

VII. EASE OF MANIPULATION.

Satisfactory to the board.

SUPPLEMENTARY TESTS.

I. DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—Thoroughly dusted; bolt moved a little stiffly, but worked well; no injury to mechanism from defective cartridges.

(*b*) *As a magazine arm.*—Well dusted; bolt at first moved with difficulty, but worked easily after couple of shots; magazine mechanism worked well; no injury from defective cartridges.

II. RUST.

All parts well rusted; bolt opened easily; both breech and magazine mechanism worked well.

No. 3.—Mannlicher (Austria).

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 30 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun having no cut-off, and it being impossible to deliver fire as a single loader holding cartridges in the magazine in reserve, 15 shots were fired as a single loader in 42 seconds; the cartridge packet was then introduced and the 5 shots fired from the magazine in 12 seconds; total, 54 seconds; 18 hits.

(*b*) *As single loader for 2 minutes.*—Eight trials were made to complete test, all of which, after firing from 3 to 14 shots, failed, on account of defective quality of the ammunition which accompanied the gun. With primed shells and bullets that also accompanied the gun cartridges were prepared, using Wetteren powder, and test completed, 38 shots being fired with 34 hits.

(*c*) *As magazine arm for 2 minutes.*—Forty-nine shots were fired and 1 cartridge left in magazine; 45 hits.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Test conducted as in the first portion of the first test, 15 shots being fired as a single loader in 31 seconds; the magazine loaded and its 5 shots fired in 9 seconds; total, 40 seconds.

(*b*) *As single loader for 1 minute and* (*c*) *as magazine arm for 1 minute.*—Tests omitted on account of scarcity of suitable ammunition.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—After first 100 shots, during which there were 9 failures to extract the extractor overriding the cartridge head, and 9 failures to ignite charge after primers had been exploded, the test was discontinued on account of the defective quality of the ammunition.

No. 4.—Mauser (Belgium).

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, ten shots in 25 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun having no cut-off this test could not be applied exactly

as contemplated; it being possible however to fire the upper cartridge in the magazine, then replace it by another, and so on, thus maintaining a single loader fire with 4 cartridges held in reserve, the test was conducted in that manner.

On the first trial after the sixteenth shot the point of the bullet of the next cartridge instead of entering the chamber impinged against the counterbore at its mouth; withdrawing the bolt the cartridge was freed and could then be pushed into chamber. Repeating the test the 16 shots were fired in 63 seconds, the 4 from the magazine in 6 seconds, total, 69 seconds; 20 hits.

(*b*) *As single loader for 2 minutes.*—Loading in this manner particular caution has to be observed not to jam the cartridge in the manner experienced in the preceding test. On five different occasions cartridges were so caught; on the sixth trial the test was successfully concluded, 31 shots being fired with 30 hits.

(*c*) *A magazine arm for 2 minutes.*—On the first trial, after 26 shots had been fired, the extractor tore through the cartridge head leaving the empty shell in the gun. On the second trial 36 shots were fired and 4 cartridges left in magazine; 35 hits.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Firing conducted as in corresponding portion of first regular test. Sixteen shots in 46 seconds, the 4 from the magazine in 5 seconds; total, 51 seconds.

(*b*) *As single loader for 1 minute.*—Eighteen shots were fired.

(*c*) *As magazine arm for 1 minute.*—After third shot the locking catch was inadvertently turned, probably by operator's sleeve or arm, and the bolt locked. Resuming the test the cartridge clip of the first charge of the magazine was carried forward with the bolt, jamming its action; this probably occurred in consequence of a slow initiatory movement of the bolt. On the third trial 21 shots were fired, and one other cartridge missed fire and was ejected. Miss-fire probably caused by operator failing to fully close the bolt before pulling trigger.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—Seventeen failures to extract, the extractor tearing through head, leaving shell in chamber, and one failure where the head resisted, and shell only extracted by blows of a hammer on the handle of the bolt. Two miss-fires, each exploded on second trial. This test was conducted in series of 50 shots, after each of which the gun was cooled by passing a stream of water through the barrel. All the failures to extract occurred in the latter portions of the sets of 50 shots, after the piece had become much heated.

The method of stripping cartridges from a clip for rapid charging of the magazine was found to be particularly trying on the operator's thumb and fingers, the operator's thumb nail being several times badly torn. This method of loading the magazine is not an essential feature of the mechanism, as cartridge could be introduced singly, but it would require a longer time.

(*b*) *As a single loader for 100 rounds.*—Four failures to extract, extractor tearing through head, leaving empty shell in chamber; three miss-fires exploded on second blow.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted; bolt opened with difficulty. When endeavoring to close the bolt a number of efforts were required before it could be entirely pushed forward; then the bolt could not be rotated, the cuts for lugs on bolt being clogged with dust that could not be removed by the hand. Test suspended until next day, when bolt was found to be internally so much clogged and rusted that all parts were firmly wedged together, thus entirely disabling the piece. Dismounting the bolt with difficulty, it was thoroughly cleaned and test repeated, the gun being well dusted; the bolt worked somewhat stiffly; the magazine worked all right.

(*b*) *Magazine loaded when exposed.*—Well dusted; bolt worked more stiffly than in previous test, but yet without much difficulty.

V. DEFECTIVE CARTRIDGES.

By the first defective shell that portion of the extractor which, when the bolt is locked, lies under the groove for the right-hand locking lug, and is therefore not supported, was so bent upwards that the bolt could not be turned until extractor had been forced down by hammer and punch. By second defective, this was repeated, the extractor being so bent that with no tools on hand could the bolt be opened. The test was then suspended.

No. 5.—Rifle, Model 1888 (Germany).

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, ten shots in 35 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun having no cut-off and it being impossible to deliver fire as a single loader holding cartridges in the magazine in reserve, 15 shots were fired as a single loader, the magazine being empty; the magazine was then loaded with one of the packets or chargers holding 5 cartridges, and magazine fire delivered for that number of shots. On the first trial the primer of the first cartridge blew out and remained in the lower recess, for the locking lug of the bolt prevented its closing.

On the second trial the 15 shots as single loader were fired in 77 seconds; the magazine loaded and the 5 shots fired in 14 seconds; total, 1 minute and 31 seconds; 20 hits.

(*b*) *As single loader for 2 minutes.*—On first trial the seventh cartridge could not be introduced into chamber, owing to the mouth of the shell being defective and split. On second trial 28 shots were fired and 1 cartridge placed in the chamber; 26 hits.

(*c*) *As magazine arm for 2 minutes.*—Twenty-four shots were fired, with 1 remaining in the magazine; 23 hits.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Test conducted as with the first portion of the first test, 15 shots in 58 seconds; the magazine loaded and the 5 shots fired in 11 seconds; total, 1 minute and 9 seconds.

(*b*) *As single loader for 1 minute.*—Eighteen shots were fired and 1 cartridge left in chamber.

(*c*) *As magazine arm for 1 minute.*—Twenty shots were fired and the fifth cartridge packet about half introduced into magazine.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—During this test several cartridges having protruding primers prevented the closing of the bolt. Also several of the cartridge packets held cartridges so firmly as to require considerable force in pushing cartridge from magazine to chamber.

(*b*) *As single loader for 100 rounds.*—Firing conducted without cartridges in magazine; gun worked well.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted; gun worked well; magazine not loaded until 15 cartridges had been fired as single loader.

(*b*) *Magazine loaded when exposed.*—Well dusted; gun worked well; firing conducted as in preceding portion of test.

V. DEFECTIVE CARTRIDGES.

By first defective the ejector piece was broken; by second defective the ejector piece was blown about 6 feet to the left, the firing pin broken in two places, one at the screw thread in cocking piece, the other at front shoulder for mainspring, and the pin and cocking piece were blown about 10 feet to the rear. The gun being thus disabled, firing was suspended.

No. 6.—Kropatschek (Portugal).

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, ten shots in 68 seconds. The gun was opened with difficulty after each discharge, requiring a smart blow of the hand on the lever to start the bolt.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The magazine holding 8 cartridges, 12 shots were fired as a single loader in 1 minute and 30 seconds, the 8 from the magazine in 50 seconds; total, 2 minutes and 20 seconds; 19 hits. Much force required to operate bolt.

(*b*) *As single loader for 2 minutes.*—Twenty-four shots were fired with 18 hits; much force required to operate bolt.

(*c*) *As magazine arm for 2 minutes.*—Sixteen shots and 5 cartridges put into magazine on its third loading; 16 hits. Much force required to operate bolt.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—On the first trial, after the eleventh shot, the extractor tore past head, leaving shell in chamber.

Repeating the test, 12 shots were fired as a single loader in 1 minute and 18 seconds, the 8 from the magazine in 42 seconds; total, 2 minutes. Bolt opened with difficulty after each shot.

(*b*) *As single loader for 1 minute.*—Seventeen shots were fired. Same force required to operate bolt.

(*c*) *As magazine arm for 1 minute.*—Thirteen shots were fired and 3 cartridges left in magazine.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—Throughout test the bolt was operated only by the exertion of considerable force; as the gun heated, blows of a hammer on the lever being required.

(*b*) *As single loader for 100 rounds.*—Same difficulty in operating bolt was experienced.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted; gun cleaned under the rules as much as possible, but mechanism was so clogged it was impossible to entirely close the bolt; magazine spring clogged with dust and spoon carrier would not operate; piece disabled and test suspended.

No. 7.—Murata (Japan).

SAFETY TEST.

The gun was operated by the recorder of the board, and fired from the shoulder 10 shots in 30 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 8 cartridges, 12 shots were first fired as a single loader in 37 seconds. The cut-off was then turned, and the 8 shots from the magazine fired in 21 seconds; total for the 20 shots, 58 seconds; 15 hits. The gun once failed to eject the empty shell.

(*b*) *As single loader for 2 minutes.*—Thirty-six shots were fired, with 35 hits.

(*c*) *As magazine arm for 2 minutes.*—The magazine was filled and its contents fired 3 times, 24 shots and 1 additional cartridge was introduced in the magazine. Twenty-one hits.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 12 shots as single loader were fired in 25 seconds, the 8 from the magazine in 13 seconds; total, 38 seconds.

(*b*) *As single-loader for 1 minute.*—Twenty-five shots were fired and 1 cartridge put in chamber.

(*c*) *As magazine arm for 1 minute.*—Sixteen shots were fired.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—During this test it was observed that if the bolt was not withdrawn with sufficient force, the ejector would fail to work and the empty shell would not be thrown out. As meanwhile the carrier would have brought up the next cartridge from the magazine, both cartridge and empty shell would at the same time be in receiver.

It was also observed that if the bolt was withdrawn strongly and smartly, the carrier, instead of merely lifting a cartridge to the receiver, would throw it clear of the gun or else into such a position that the bolt by its forward motion could not push it into the chamber.

Though care was exercised to avoid these two faults, the former (failure to eject) occurred 4 times and the latter 19 times.

There were also 2 failures to extract, the extractor overriding the cartridge head, and 11 miss-fires, all occasioned by the firing pin not giving a strong enough blow to primers somewhat deep-seated. The bolt worked rather stiffly.

(*b*) *As single loader for 100 rounds.*—The gun satisfactorily endured the test.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Gun well dusted. Bolt worked with great difficulty; bound when handle used to move it forward; could only be closed by pushing against the rear end.

(*b*) *Magazine loaded when exposed.*—Bolt worked with difficulty. Head of magazine spring obstructed by dust, and fed last cartridge only half way on to carrier.

V. DEFECTIVE CARTRIDGES.

No injury whatever to mechanism from the three forms of defective cartridges.

VI. EXCESSIVE CHARGES.

Bolt worked with difficulty; cartridges barely thrown out by ejector.

VII. EASE OF MANIPULATION.

Not entirely satisfactory.

No 8.—Schmidt (Switzerland).

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 35 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 8 shots as a single loader were fired in 28 seconds, the magazine then turned on and its 12 shots fired in 28 seconds; total, 56 seconds; 16 hits. One empty shell not ejected.

(*b*) *As single loader for 2 minutes.*—Thirty-one shots were fired, with 25 hits.

(*c*) *As magazine arm for 2 minutes.*—The gun was loaded with 8 packets, 48 cartridges, of which 37 were fired (with 32 hits); 1 cartridge left in chamber, 8 left in magazine, and 2 jumped out of magazine in operating.

II. RAPIDITY AT WILL.

(*a*) *As single-loader and then as repeating arm for contents of magazine.*—Time, 20 seconds for 8 shots and 18 seconds for the 12 from the magazine; total, 38 seconds.

(*b*) *As single-loader for 1 minute.*—Eighteen shots were fired.

(*c*) *As magazine arm for 1 minute.*—Seventeen shots were fired in 35 seconds, when the cocking piece, hitting the hand of the operator in closing, was turned and mechanism blocked. On second trial 25 shots were fired, with 11 cartridges left in the magazine.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—After 250 shots had been fired, a burr on the locking lugs prevented the closing of the bolt; mechanism dismounted and burr removed on emery wheel and test concluded. There were 49 failures to extract, the hook of extractor sliding up and overhead and leaving shell in the chamber, from which in 41 cases it had to be driven out with a rod. As gun became heated it worked very stiffly.

(*b*) *As single loader for 100 rounds.*—Five failures to extract. Gun worked stiffly. The bullet of upper cartridge in magazine so deformed that it jammed when endeavoring to feed it into chamber on completion of the single-loading fire.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted; worked well, but stiffly.

(*b*) *Magazine loaded when exposed.*—Well dusted; worked stiffly.

V. DEFECTIVE CARTRIDGES.

By the first defective the bolt was not injured, but the magazine was broken into four pieces and blown clear of the gun. Other defectives not fired.

VI. EXCESSIVE CHARGES.

Test omitted.

VII. EASE OF MANIPULATION.

Manipulation considered difficult, as it required an excessive exertion of force.

No. 9.—Mannlicher Carbine (Austria).

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 28 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun having no cut-off and it being impossible to deliver fire as a single loader holding cartridges in the magazine in reserve, 15 shots were fired as a single loader, the magazine being empty; the magazine was then loaded with one of the packets or chargers holding 5 cartridges and magazine fire delivered for that number of shots.

Time for the 15 shots, 46 seconds; the packet was then introduced and its cartridges fired in 13 seconds; total, 59 seconds; 16 hits.

(*b*) *As single loader for 2 minutes.*—Thirty-eight shots were fired with 35 hits.

(*c*) *As magazine arm for 2 minutes.*—After 2 shots had been fired, the magazine spring did not bring up the next cartridge quickly enough to prevent the bolt driving it forward before it had fully risen, causing a jam of the head against the shoulders of the receiver.

On a second trial, 35 shots had been fired in 1 minute and 54 seconds, with 29 hits, when the thirty-sixth cartridge was also jammed.

On the third trial, 14 shots were fired in 45 seconds with 11 hits, when the jam again occurred with the fifteenth cartridge.

On the fourth trial 40 shots were fired with 27 hits. Mechanism worked stiffly.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Test conducted as with the first portion of the first test, 15 shots in 37 seconds; the magazine loaded and its 5 shots fired in 11 seconds; total, 48 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-five shots were fired.

(*c*) *As magazine arm for 1 minute.*—Thirty-seven shots were fired, with 3 cartridges left in magazine.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—On account of a scarcity of the particular ammunition adapted to this arm but 100 shots were fired. Mechanism worked well except rather stiffly, due to gradual accumulation of fouling from the Wetteren powder, with which the cartridges were loaded, in the channel for movement of locking lug in left face of casing.

(*b*) *As single loader for 100 rounds.*—Test omitted for lack of ammunition.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted; mechanism worked stiffly; difficulty at first experienced in entirely closing bolt.

(*b*) *Magazine loaded when exposed.*—Well dusted; mechanism worked very stiffly; same difficulty experienced in closing bolt.

V. DEFECTIVE CARTRIDGES.

No injury whatever to mechanism from the three forms of defective cartridges.

VI. EXCESSIVE CHARGES.

Mechanism worked well.

VII. EASE OF MANIPULATION.

Manipulation easy if piece was brought down from the shoulder after each shot, but if advantage was taken of the straight action to keep the arm at the shoulder, while the 5 cartridges in the magazine were fired, it required considerable exertion to completely close the mechanism, and as there was no rotating handle to indicate the extent to which the bolthead had been turned, endeavor would be made occasionally to pull the trigger before the mechanism was in the firing position.

The sudden exertion of force required to start the bolt was also deemed objectionable by the board.

SUPPLEMENTARY TESTS.

I. DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—No injury from first and second defectives. After first dusting, the dust and fouling prevented manipulation of the bolt except by using a mallet. Test suspended.

No. 10.—MANNLICHER (ROUMANIA).

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 26 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun having no cut-off and it being impossible to deliver fire as a single loader holding cartridges in the magazine in reserve, 15 shots were fired as a single loader, the magazine being empty; the magazine was then loaded with one of the packets or chargers holding 5 cartridges and magazine fire delivered for that number of shots.

Time for the 15 shots, 40 seconds; the packet was then introduced and its cartridges fired in 12 seconds; total, 52 seconds; 19 hits.

(*b*) *As single loader for 2 minutes.*—Forty-one shots were fired with 38 hits.

(*c*) *As magazine arm for 2 minutes.*—Forty-eight shots were fired with 2 cartridges left in the magazine; 48 hits.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Test conducted as with the first portion of the first test; 15 shots in 34 seconds; the magazine loaded and its 5 cartridges fired in 6 seconds; total, 40 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-three shots were fired.

(*c*) *As magazine arm for 1 minute.*—Twenty-nine shots were fired in 46 seconds, when the supply of ammunition furnished the operator having been exhausted, firing was necessarily stopped. Repeating the test, 40 shots were fired in 1 minute.

ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—Mechanism worked well throughout the test.

(*b*) *As single loader for 100 rounds.*—Mechanism worked well.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted. The accumulation of dust in the channels and recess for the locking lugs, where it could not be reached by the operator's finger, caused some difficulty at first in opening and closing. Afterwards worked well.

(*b*) *Magazine loaded when exposed.*—Well dusted. Same difficulty at first experienced as in preceding test, and in addition the dust accumulating in the channels in the bolt for the firing pin and striker prevented the latter reaching the primer. Dismounting the bolt (which can be quickly done without tools) and wiping the parts with the hand, firing could be conducted on assembling.

V. DEFECTIVE CARTRIDGES.

No injury whatever to mechanism from the three forms of defective cartridges.

VI. EXCESSIVE CHARGES.

Test omitted, no proper cartridges being available.

VII. EASE OF MANIPULATION.

Satisfactory to the board.

SUPPLEMENTARY TESTS.

I. DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—No injury whatever from the defectives. Dust caused such clogging that it was necessary to use a mallet to open the bolt before the first and second shots after exposure.

(*b*) *As a magazine arm.*—Use of mallet again required at first. Mechanism afterwards worked well.

II. RUST.

All parts thoroughly rusted. Bolt handle could not be moved or mechanism operated. Impossible to fire the gun.

ADDITIONAL TEST.

To determine the rapidity of fire of this arm in the hands of an instructed but not particularly expert soldier, it was fired by an enlisted man of the ordnance detachment at Springfield Armory, who had previously served an enlistment in the Second United States Cavalry, with aim at an A target at a range of 100 yards.

Loading from the cartridge belt, 15 shots were fired as a single loader in 1 minute and 42 seconds; a cartridge packet was then introduced into the magazine and its 5 cartridges fired in 23 seconds; total for the 20 shots, 2 minutes and 5 seconds.

The supply of ammunition for this arm would not permit of further extending this trial.

No. 11.—Russian.

Record of the tests of this gun is omitted from this report, the arm itself having been received from the Russian Government with the understanding it should be considered as confidential.

No. 12.—Berthier No. 1.

SAFETY TEST.

The gun was operated by Mr. Laurence V. Benét, representing the Hotchkiss Ordnance Company, and fired from the shoulder, 10 shots in 35 seconds. There were 4 miss-fires; of these 2 exploded on second, and 2 on the third trial.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun having no cut-off, and it being impossible to deliver fire as a single loader, holding cartridges in the magazine in reserve, 16 shots were first fired as a single loader, the magazine being empty; the magazine was then loaded with one of its packets or chargers holding 4 cartridges and magazine fire delivered for that number of shots. On the first trial after the 16 shots as single loader had been fired in 49 seconds, the bolt, after the packet had been introduced, struck against its upper lips, they being defective, and compelled suspension of the test.

On the second trial the shots as single loader were fired in 48 seconds, the magazine then introduced and its 4 shots fired in 11 seconds; total, 59 seconds; 16 hits. As there were 2 miss-fires, only 18 shots were actually fired; of the miss-fires one went on first and one on second trial.

(*b*) *As single loader for 2 minutes.*—On the first trial, after 23 shots had been fired in 65 seconds, the extractor tore past the head of the last shell, leaving it in the gun. There had actually been but 22 shots fired, as one failed to explode (went on second trial); 20 hits.

On second trial, 12 shots in 30 seconds; last shell not extracted; 1 miss-fire, which went on second attempt; 11 actual shots; 10 hits.

On third trial, 38 shots were fired (as there were 10 miss-fires but 28 actual shots); 26 hits. Of the miss-fires, 5 went on second trial and 2 on third; the balance failed.

(*c*) *As magazine arm for 2 minutes.*—On first trial, in 65 seconds, 16 shots were fired, and a packet (4 cartridges) introduced into magazine. As there were 5 miss-fires but 11 actual shots were delivered; 11 hits. The sixteenth shell was not extracted; of the miss-fires 2 exploded on second trial and 1 on third; 2 failed.

Second trial. Sixteen shots in 48 seconds, and 4 cartridges introduced into magazine; 5 miss-fires; 11 hits. Of the miss-fires, 2 exploded on second, 2 on third trial, and 1 failed. Last shell not extracted.

Third trial. Twelve shots in 40 seconds, with 1 miss-fire; 9 hits. Defective lip of next packet prevented closing of bolt. The miss-fire went on second trial.

Fourth trial. After 7 shots, with 2 miss-fires and 4 hits, and a cartridge left in magazine, in 18 seconds, the bolt, in the act of closing, overrode the head of the cartridge in the magazine, which was lifted too slowly and jammed against the side of the shell. The miss-fires went on second trial.

Fifth trial. The seventeenth shell was not extracted after the operation of delivering 17 shots (3 of them miss-fires) had been executed in 52 seconds. There were 13 hits and 3 cartridges left in magazine. Of the miss-fires, 1 went on second, 2 on third trial.

Sixth trial. In 78 seconds, 21 shots, 3 cartridges in magazine; 4 miss-fires; 15 hits; twenty-first shell was not extracted. Miss-fires: 3 went on second, 1 on third trial.

Seventh trial. In 47 seconds, 18 shots; 3 miss-fires (2 exploded on second, 1 on third trial); 15 hits; 2 cartridges in magazine. Last shell not extracted.

Eighth trial. The packet catch, its spring weakening, failed to retain cartridge packet in magazine. Tests suspended. Gun withdrawn by permission of the board.

No. 13.—Mauser No. 2.

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 28 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun having no cut-off, test was conducted as with Mauser No. 1.

The 16 shots were fired in 72 seconds, the 4 from the magazine in 8 seconds; total, 80 seconds; 19 hits. One miss-fire, probably occasioned by operator not completely closing the bolt before pulling trigger.

(*b*) *As a single loader for 2 minutes.*—Forty-two shots were fired with 37 hits.

(*c*) *As magazine arm for 2 minutes.*—Forty shots were fired with 39 hits.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Firing conducted as in corresponding portion of first regular test. Sixteen shots in 56 seconds, the 4 from the magazine in 6 seconds; total, 62 seconds. One miss-fire, probably occasioned by operator failing to completely close bolt.

(*b*) *As single loader for 1 minute.*—Twenty-five shots were fired.

(*c*) *As magazine arm for 1 minute.*—Thirty shots were fired.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—After the firing had been about one-half concluded, the last 2 cartridges from each magazine were frequently not sufficiently lifted by the magazine spring, and the point of the bullet impinging against bottom portion only of the ramp at front of receiver, did not rise along it until assisted by pressure from the hand underneath the magazine box. This was occasioned by the front guard-plate screw working loose, and permitting the forward part of the magazine to fall slightly.

After about the four hundredth shot this assistance had to be given for all but the upper cartridge from each magazine.

After the full test was concluded the guard-plate screw was set home and a few additional shots fired. The magazine then worked all right.

(*b*) *As single loader for 100 rounds.*—Mechanism worked well.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted. Bolt worked a little stiffly.

(*b*) *Magazine loaded when exposed.*—Well dusted. Dust and previous fouling prevented at first the full withdrawal of the bolt, and consequently the first three empty shells were not ejected from the receiver. For the remaining seventeen shots the machanism worked well.

V. DEFECTIVE CARTRIDGES.

The first defective blew out the ejector and bolt stop, and so bent the extractor that the bolt could not be turned.

Tests discontinued.

No. 14.—Sporer.

SAFETY TEST.

The gun was operated by the recorder of the board, loading, aiming, and endeavoring to fire the 10 cartridges; time, 35 seconds. There were 8 miss-fires, the primer not being fully reached by firing pin.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, it was en-

deavored to fire 15 as a single loader; of these 13 failed for same reason as in safety test. When the magazine was turned on, the first cartridge jammed under bolt. Repeating latter portion of test, the first and second cartridges were together fed into chamber and receiver, jamming the action. Test suspended and gun subsequently withdrawn.

No. 15.—Bruce No. 1.

SAFETY TEST.

The gun was operated by the recorder of the board, and fired from the shoulder, 10 shots in 35 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were fired as a single loader. On the first trial after the first shot the magazine catch opened, releasing the magazine; on second and third trials this also occurred; on fourth trial the test was completed, 15 shots being fired in 39 seconds, the 5 from the magazine in 12 seconds; total, 51 seconds; 19 hits.

(*b*) *As single loader for 2 minutes.*—Thirty-eight shots were fired, with 36 hits. Bolt worked stiffly.

(*c*) *As magazine arm for 2 minutes.*—After 6 shots had been fired in 30 seconds, the seventh cartridge (the second of the second magazine) jammed in the receiver, the point of the bullet striking against counter bore above barrel; withdrawing the bolt the cartridge fell, and could be pushed by the bolt into receiver.

Repeating the test, 34 shots were fired and 1 cartridge left in chamber; 31 hits.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as single loader were fired in 29 seconds, the 5 from magazine in 6 seconds; total, 35 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-five shots were fired and 1 cartridge introduced in chamber.

(*c*) *As magazine arm for 1 minute.*—Twenty shots were fired and the magazine charged with its 5 cartridges.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—Bolt worked stiffly as the gun became heated towards the close of each set of 50 shots.

(*b*) *As single loader for 100 rounds.*—During this test the magazine catch frequently partly or entirely opened, in the latter cases permitting the magazine to revolve, and in the former to partly fall, dropping the points of the bullets and sufficiently raising the heads of the upper cartridges to occasionally interfere with the motion of the bolt. In

several instances the mechanism worked so stiffly as to require blows from a hammer on the lever to open the bolt.

IV. DUST.

(*a*) *Magazine empty when exposed.*—The overhang of receiver preventing the introduction of finger, the recess for front locking lug could not be cleaned of dust, thus preventing the entire closing of bolt. Dust in hollow of bolt at firing-pin hole limited throw of firing pin. After many efforts the bolt was closed and firing completed.

(*b*) *Magazine loaded when exposed.*—Same difficulties experienced as in preceding portion of test.

V. DEFECTIVE CARTRIDGES.

By first defective, the extractor was broken near rear of bolt and part blown about 10 feet to right and rear of gun.

Repeating the test with new extractor, the extractor was revolved or turned to the right about 45°, freeing the claw from the bolthead. Could not be replaced; test suspended and gun withdrawn for repairs.

No. 16.—Bruce No. 2.

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 38 seconds.

REGULAR TESTS

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were fired as a single loader; time, 55 seconds; the five from the magazine in 15 seconds; total, 1 minute and 10 seconds; 20 hits. Two primers pierced by firing pin, which slightly delayed operator.

(*b*) *As a single loader for 2 minutes.*—Thirty-six shots were fired, with 26 hits. The last shell was left in the chamber, the extractor overriding the cartridge head. Bolt worked stiffly.

(*c*) *As magazine arm for 2 minutes.*—Thirty-one shots were fired with 24 hits, and 1 cartridge was left in chamber. The cartridges not being always quickly and readily withdrawn from the loading packet, the operator twice introduced but 4 instead of 5 when loading the magazine.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as single loader were fired in 40 seconds, the 5 from the magazine in 12 seconds; total, 52 seconds. Once during the fire as single loader the magazine catch opened, releasing the magazine, which operator then closed without ceasing to fire.

(*b*) *As single loader for 1 minute.*—Twenty-seven shots were fired.

(*c*) *As magazine arm for 1 minute.*—Twenty-four shots were fired. As in a preceding test, the operator, endeavoring to load magazine quickly, once introduced but 4 of the 5 cartridges from a loading packet.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—Bolt worked stiffly as the gun became heated. After 150 shots had been fired it was noticed that the hinge-pin screw of magazine was working loose; 100 shots later screw was tightened to prevent its falling out. After the two hundred and sixty-seventh shot the next cartridge (the third from that magazine) was not fed sufficiently high into receiver to be impinged upon by head of bolt; cause not discovered. The occurrence was not repeated.

(*b*) *As single loader for 100 rounds.*—Magazine catch opened three times sufficiently to permit magazine to fall. It partly opened many other times.

IV. DUST.

(*a*) *Magazine empty when exposed.*—The second cartridge from magazine not fed into receiver, the catch having opened and magazine fallen. Dust did not interfere with mechanism further than making last shell very difficult to extract, blows from a hammer on the bolt handle being necessary.

(*b*) *Magazine loaded when exposed.*—The bullet of the second cartridge from magazine struck against counterbore above chamber, where it was held by the pressure of bolt on cartridge head; partly withdrawing the bolt, the cartridge was freed and was then pushed into chamber. Mechanism worked stiffly.

V. DEFECTIVE CARTRIDGES.

No injury whatever to mechanism from the three forms of defectives.

VI. EXCESSIVE CHARGES.

Test satisfactory.

VII. EASE OF MANIPULATION.

Mechanism always required the exertion of considerable force to operate.

SUPPLEMENTARY TESTS.

I. DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—No injury from the defective cartridges. After the first dusting the interior of the bolt (the firing-pin hole) was so clogged with dust that the firing pin could not be forced sufficiently forward to strike the cartridge. The gun in that condition being then disabled, it was decided to dismount and clean the bolt. When bolt had been thoroughly cleaned the test was resumed and concluded without incident.

(*b*) *As a magazine arm.*—After the first two defective cartridges had been fired and gun dusted, it was discovered that one of the small screws securing the guide on interior of magazine had worked loose and fallen out; the cartridges were consequently retained in magazine and not fed properly from it.

No. 17.—Krag-Jörgensen No. 2.

In the preliminary handling of the gun when first submitted it was discovered, when the cartridges known as "improved heads" were used, that the bolt did not close easily, the head space being insufficient; cartridges as first used by the board, with heads somewhat sloped off on the under surface, were therefore substituted.

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 32 seconds.

REGULAR TEST.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were first fired as a single loader in 47 seconds, those from the magazine in 10 seconds; total, 57 seconds; 19 hits.

(*b*) *As a single loader for 2 minutes.*—Forty-one shots were fired with 23 hits. One empty shell not ejected.

(*c*) *As magazine arm for 2 minutes.*—On first trial the failures to eject several shells caused so much delay that the test was repeated. On second trial 34 shots were fired and 4 cartridges left in the magazine; 31 hits. Two cartridges were dropped in transfer from loading packet to magazine.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Time, 29 seconds for 15 shots, and 7 seconds more for those in magazine; total, 36 seconds.

(*b*) *As single loader for 1 minute.*—Failure to eject after 18 shots had been fired in 50 seconds. Test repeated, 29 shots being fired.

(*c*) *As magazine arm for 1 minute.*—Failure to eject caused test to be made 4 times without completion. On fifth trial test was completed, 26 shots being fired; 2 failures to eject occurred.

The inventors being of the opinion (in which the board concurred) that the failures to eject were due to the form of the cartridge head, which did not permit the extractor to retain its hold until the shell was sufficiently retracted; the gun was withdrawn to so alter the counterbore as to allow the use of the cartridges with improved heads.

No. 18.—Krag-Jorgensen No. 3.

SAFETY TEST.

The gun was operated by the recorder of the board, and fired from the shoulder, 10 shots in 32 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were first fired as a single loader, in 43 seconds, then the magazine turned on and its 5 shots fired in 12 seconds; total time, 55 seconds; 18 hits.

(*b*) *As a single loader for 2 minutes.*—Forty-two shots were fired, making 35 hits.

(*c*) *As magazine arm for 2 minutes.*—Forty shots were fired with 39 hits, and 5 more cartridges (its capacity) introduced into the magazine.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as single loader were fired in 28 seconds, those from the magazine in 6 seconds; total time, 34 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-six shots were fired.

(*c*) *As magazine arm for 1 minute.*—Twenty-nine shots were fired, 1 cartridge left in chamber and 4 in the magazine. One other cartridge dropped in transferring from loading packet to magazine. During this test the small pin retaining locking catch in place fell out and was lost.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—Breech and magazine mechanism worked well and easily in all particulars.

(*b*) *As single loader for 100 rounds.*—Mechanism worked well and easily in all particulars.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Mechanism thoroughly dusted; gun worked freely.

(*b*) *Magazine loaded when exposed.*—Mechanism thoroughly dusted; gun worked freely.

V. DEFECTIVE CARTRIDGES.

No injury whatever to mechanism from the three forms of defectives; gun worked well.

VI. EXCESSIVE CHARGES.

Bolt opened easily; mechanism worked freely and well.

VII. EASE OF MANIPULATION.

Satisfactory to the board.

SUPPLEMENTARY TESTS.

I. DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—Endured the first dusting and firing with defective cartridges in a satisfactory manner.

When defectives were repeated the claw of extractor was slightly

bent, and when subsequently fired after second dusting, while the empty shells were withdrawn from chamber, the extractor did not hold them up to the ejector, and they were left in the receiver. Otherwise mechanism worked satisfactorily.

(*b*) *As a magazine arm.*—Except the failure to eject, mentioned in previous test, the mechanism worked well.

II. RUST.

The gun not being sufficiently rusted from the first exposure, it was a second time subjected to the sal-ammoniac solution and again exposed. When examined was found to be fairly well rusted.

The test was then completed; bolt was opened by the hand alone, with but little difficulty; mechanism worked stiffly but well.

III. EXPLOSIONS IN MAGAZINE.

Not liable to occur.

IV. DISMOUNTING AND ASSEMBLING.

Bolt dismounted and assembled without the use of any tools. Screw-driver only required for the magazine.

Work can be done quickly and easily.

No. 19.—Krag-Jörgensen No. 4.

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 28 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as single loader were fired in 44 seconds, the 5 from the magazine in 10 seconds; total, 54 seconds; 17 hits.

(*b*) *As single loader for 2 minutes.*—Thirty-nine shots were fired with 38 hits.

(*c*) *As magazine arm for 2 minutes.*—Thirty-seven shots were fired with 35 hits; 3 cartridges left in magazine.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Time, 31 seconds for 15 shots, and 7 seconds for the 5 from magazine; total, 38 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-eight shots were fired and one cartridge introduced into chamber.

(*c*) *As magazine arm for 1 minute.*—Thirty-five shots were fired.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—Except the occasional necessity for exertion of increased force in pushing cartridge from the magazine to the chamber, the mechanism worked well.

(*b*) *As single loader for 100 rounds.*—The mechanism worked well and easily.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted; mechanism worked freely.

(*b*) *Magazine loaded when exposed.*—Well dusted; mechanism worked freely.

V. DEFECTIVE CARTRIDGES.

When fired with the first defective cartridge, the dust cover was ruptured along its juncture with left side of receiver, and cracked across the top, and that portion of the receiver over rear part of bolt was also cracked. Bolt could not be opened. Gun withdrawn.

No. 20.—Bruce No. 3.

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 34 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were first fired as a single loader; time, 48 seconds.

The magazine was then turned on and emptied in 14 seconds; total, 62 seconds; 16 hits; 1 cartridge from magazine was only partly fed into chamber and extracted without firing. Only 19 shots actually fired.

(*b*) *As a single loader for 2 minutes.*—Thirty-seven shots were fired, making 28 hits.

Excessive weight of gun and operator's fatigue caused inaccuracy toward conclusion of test.

(*c*) *As magazine arm for 2 minutes.*—Twenty-three shots were fired and 4 cartridges left in magazine.

The difficulty attending transfer of cartridges from loading packet to magazine caused 2 to be dropped in loading. One miss-fire; the cartridge was extracted but not ejected; 16 hits.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as a single loader were fired in 35 seconds, the 5 from the magazine in 15 seconds; total, 50 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-seven shots were fired.

(*c*) *As magazine arm for 1 minute.*—Fourteen shots were fired and 1 cartridge dropped in transfer from loading packet to magazine.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—As the firing progressed it gradually became difficult to so far withdraw the magazine catch as to cause the entire retraction of the magazine spring. After the three hundredth shot, blows from a hammer were frequently necessary.

(*b*) *As single loader for 100 rounds.*—Mechanism worked well.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Hammer and drift required to move magazine catch, and pressure through receiver on magazine spring before the magazine could be opened; spring then not retracted and had to be held down by hand while loading magazine.

(*b*) *Magazine loaded when exposed.*—Same difficulties experienced as in preceding portion of dust test, but in even a more pronounced degree. Test suspended.

No. 21.—Berthier No. 2.

SAFETY TEST.

The gun was operated by Mr. Laurence V. Benét, representing the Hotchkiss Ordnance Company, and fired from the shoulder 8 shots in 38 seconds. After the last shot the extractor tore past the cartridge head, leaving the empty shell in the chamber.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun having no cut-off, and it being impossible to deliver fire as a single loader holding cartridges in the magazine in reserve, 16 shots were first fired as a single loader with magazine empty. The magazine was then loaded with one of its packets holding 4 cartridges, and magazine fire to that extent delivered.

On the first trial the 16 shots were fired in 50 seconds; the packet introduced and 2 shots fired in 15 seconds; the extractor then slipped over cartridge head, leaving empty shell in the gun; 3 miss-fires, 13 hits; of the miss-fires, 1 went on second trial, balance failed on third.

Second trial: The 16 shots as single loader were fired in 45 seconds; the packet introduced and its 4 cartridges fired in 15 seconds; total, 60 seconds. There were 5 miss-fires, leaving 15 shots actually delivered; 11 hits. Of the miss-fires, 2 each exploded on the second and third trials, and 1 failed on the latter.

(*b*) *As single loader for 2 minutes.*—On first trial after 13 shots, with 13 hits, had been fired in 47 seconds the extractor failed to remove the last empty shell. On second trial 37 shots were fired, of which 9 were miss-fires, with 28 hits. Of the miss-fires 3 each exploded on the second and third trials, and 3 failed on the latter.

(*c*) *As magazine arm for 2 minutes.*—First trial: After 20 shots (4 failures, of which 1 went on second trial and remainder failed on third trial) with 15 hits, the extractor failed to remove the last shell.

Second to sixth trial, inclusive: In every case the third cartridge from the packet was not brought up sufficiently by the magazine spring to enable the bolt to bear against the cartridge head.

Seventh trial: Twenty shots were fired in 70 seconds; there were 8 miss-fires (of which 5 exploded on second trial, 2 on third, and 1 then failed), and 12 hits. Firing conducted with deliberation and action of mechanism assisted by operator. Tests then suspended. Gun withdrawn by permission of the board.

No. 22.—Pitcher Magazine Rifle.

SAFETY TEST.

The 10 shots for safety were fired with a lanyard, the gun being in a fixed rest. At each discharge the cover slide was driven back distances varying between 0.4 and 0.45 of an inch.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Test omitted, it being deemed dangerous to fire the gun from the shoulder.

(*b*) *As a single loader for 2 minutes.*—Test omitted, it being deemed dangerous to fire the gun from the shoulder.

(*c*) *As magazine arm for 2 minutes.*—Test omitted, it being deemed dangerous to fire the gun from the shoulder.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Test omitted, it being deemed dangerous to fire the gun from the shoulder.

(*b*) *As single loader for 1 minute.*—Test omitted, it being deemed dangerous to fire the gun from the shoulder.

(*c*) *As magazine arm for 1 minute.*—Test omitted, it being deemed dangerous to fire the gun from the shoulder.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—Test omitted.

(*b*) *As single loader for 100 rounds.*—Twenty-seven shots in all were fired with the gun in a fixed rest. With each shot the cover slide was driven back distances varying from 0.42 inch to 0.52 inch, causing the latches to come into bearing and to commence the unlocking of the piece. After the nineteenth round blows of a hammer were required to entirely close the mechanism; after the twenty-first, the trigger could not be operated until the bolt had been moved back and forth several times; this recurred with succeeding shots until, after the twenty-seventh, it became impossible to continue firing.

Test suspended, mechanism refusing to operate, it being impossible to move the cover slide without blows from a hammer.

No. 23.—Berthier No. 3.

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 32 seconds. There were 3 miss-fires, of which 1 exploded on second, 1 on third trial, and 1 failed.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun having no cut-off and it being impossible to deliver fire as a single loader holding cartridges in the magazine in reserve, 16 shots were first fired as a single loader, with magazine empty; the magazine was then loaded with one of its packets, holding 4 cartridges, and magazine fire to that extent delivered.

On the first trial the 16 shots as single loader were fired in 46 seconds; the packet then introduced; but in feeding its first cartridge the point of bullet jammed under ramp at front of magazine cut. There were 2 miss-fires, of which 1 went on second and 1 failed on third trial. Eleven hits.

On second trial the 16 shots were fired in 45 seconds; the packet introduced and 3 shots fired in 10 seconds. The last cartridge from the magazine was not fully fed into receiver and bullet jammed against front of cut. Four miss-fires; 2 went on second, 2 failed on third trial. Eleven hits.

On third trial, 14 shots were fired as a single loader, in 40 seconds, when the extractor rose over cartridge head, leaving the empty shell in the chamber. There were 4 miss-fires, of which 2 exploded on second and 2 failed on third trial. Eight hits.

Fourth trial: The 16 shots were fired in 46 seconds and the packet then introduced, but its first cartridge jammed, as in a previous case. Seven miss-fires; 1 exploded on second, 3 on third trial, and 3 failed.

Fifth trial: The 16 shots were fired in 43 seconds; the packet introduced, and 3 shots fired in 9 seconds, when the last cartridge from magazine was not fully fed up into receiver, the point of bullet jamming against ramp at front of magazine cut.

There were 5 miss-fires, 1 on second, 1 on third trial, and 3 failed. Test discontinued.

No. 24.—Mauser No. 3.

SAFETY TEST.

The gun was operated by Mr. Alfons Mauser and fired from the shoulder, 10 shots in 43 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were

first fired as a single loader in 40 seconds, then the magazine turned on and its 5 shots fired in 9 seconds; total time, 49 seconds; 17 hits.

(*b*) *As single loader for 2 minutes.*—Forty shots were fired and 1 cartridge introduced into chamber; 34 hits.

(*c*) *As magazine arm for 2 minutes.*—On the first trial, after 31 shots had been fired in 1 minute and 40 seconds, with 29 hits, test was suspended in consequence of the difficulty experienced in stripping the cartridges from the clip last introduced.

During the trial but 1 cartridge was stripped from one of the clips, the clip and its remaining 4 cartridges being then thrown aside in consequence of the difficulty of stripping them.

On second trial 20 shots were fired in 1 minute, with 20 hits, 1 cartridge left in chamber and 4 in magazine, when operator inadvertently bringing back bolt before cartridge was fully in chamber fed forward a second cartridge, jamming the mechanism.

On third trial 40 shots were fired with 37 hits, 1 cartridge left in chamber. During the trial in one case a single cartridge only was introduced from 1 clip in consequence of the difficulty of stripping.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—On the first trial, the second cartridge not being fully placed in the receiver, the point of the bullet caught against the right side of the casing, causing a jam.

On second trial the 15 cartridges as a single-loader were fired in 32 seconds, the 5 from the magazine in 8 seconds; total, 40 seconds.

(*b*) *As single loader for 1 minute.*—Thirty shots were fired.

(*c*) *As magazine arm for 1 minute.*—Fifteen shots were fired. Much delay, caused by the difficulty in stripping the cartridges from the clips to the magazine.

III. ENDURANCE.

(*a*) *As magazine arm for 500 rounds.*—Breech and magazine mechanism worked well.

(*b*) *As single loader for 100 rounds.*—Mechanism worked well.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted. Gun worked well.

(*b*) *Magazine loaded when exposed.*—Well dusted. Difficulty experienced in turning on magazine after single-loader fire; otherwise worked well.

V. DEFECTIVE CARTRIDGES.

Extractor slightly sprung after second defective; after forcing back, bolt could be withdrawn.

VI. EXCESSIVE CHARGES.

Bolt opened easily; mechanism worked well.

VII. EASE OF MANIPULATION.

Satisfactory as a single loader or as a magazine arm after the magazine has been filled. Operation of charging magazine from the clips submitted slow and difficult.

No. 25.—Lee No. 1.

SAFETY TEST.

The gun was operated by Mr. J. P. Lee and fired from the shoulder, 10 shots in 36 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 10 cartridges, it was endeavored to first fire that number of shots as a single loader and then the 10 from the magazine.

On the first trial the 10 shots as single loader were fired in 29 seconds and 8 shots from the magazine in 21 seconds; 18 hits; when the next cartridge, the ninth, from the magazine not being fully fed up, the point of the bullet, as the bolt pushed the cartridge forward, impinged against the front of the box below the ramp at front of receiver, instead of rising along it, causing a jam.

On second trial the 10 shots were fired in 27 seconds and 8 from the magazine in 18 seconds; 18 hits; when the same difficulty was experienced with the ninth cartridge from the magazine as on the first trial.

On the third trial the 10 shots as single loader were fired in 30 seconds and 9 from the magazine in 15 seconds, when with the tenth, the last from the magazine, the same difficulty was again experienced. On this trial there were 2 miss-fires and 1 shot fired before the trigger was pulled, the engagement of the sear in the notch of the cocking piece being very slight.

On the fourth trial the 10 shots were first fired in 29 seconds and 3 shots from the magazine in 8 seconds, when with the fourth cartridge from the magazine the difficulty above mentioned was again experienced.

Fifth trial, 10 shots in 28 seconds. After turning on the magazine the cocking piece slipped forward on the bolt, blocking the mechanism.

Test then suspended and gun withdrawn by exhibitor.

No. 26.—Lee No. 2.

SAFETY TEST.

The gun was operated by Mr. J. P. Lee and fired from the shoulder, 10 shots in 38 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were first fired as a single loader in 41 seconds; the magazine turned on and the 5 shots fired in 10 seconds; total, 51 seconds; 19 hits.

(*b*) *As single loader for 2 minutes.*—Forty-four shots were fired, of which 1 missed fire, with 40 hits.

(*c*) *As magazine arm for 2 minutes.*—Twenty shots were fired, with 19 hits, and 1 cartridge left in the chamber and 4 in magazine.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Twenty-seven seconds for the 15 shots as single loader, and 7 for the 5 from the magazine; total, 34 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-five shots were fired and 1 cartridge left in chamber.

(*c*) *As magazine arm for 1 minute.*—Fourteen shots were fired and 1 cartridge left in chamber.

III. ENDURANCE.

(*a*) *As magazine arm for 500 rounds.*—After the first 50 shots had been fired the cartridges occasionally missed fire on first trial; all exploded on second trial. There were in all 28 miss-fires. Otherwise mechanism worked well.

(*b*) *As single loader for 100 rounds.*—Twelve miss-fires, of which all exploded on second trial. Otherwise mechanism worked well.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Three miss-fires. Second and third cartridges from magazine not brought up into receiver.

(*b*) *Magazine loaded when exposed.*—Second cartridge from magazine not brought up into receiver. Magazine spring worked slowly and stiffly.

Tests suspended. Gun withdrawn by exhibitor.

No. 27.—Mauser No. 4.

SAFETY TEST.

The gun was operated by Mr. Alfons Mauser and fired from the shoulder, 10 shots in 26 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun having no cut-off, 15 shots were first fired as a single loader, with magazine empty, in 46 seconds; 5 cartridges (its capacity) were then stripped from loading clips into magazine and fired therefrom in 14 seconds; total, 60 seconds; 16 hits.

(*b*) *As single loader for 2 minutes.*—Forty shots were fired, with 39 hits.

(*c*) *As magazine arm for 2 minutes.*—Thirty-seven shots were fired, with 36 hits. One cartridge was left in magazine and 1 in chamber. On one occasion but 4 cartridges were stripped from clip in charging magazine.

II RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Test conducted as with first portion of first test. On the first trial the 15 shots as single loader were fired in 32 seconds, when, operator experiencing so much difficulty in stripping cartridges from clip to magazine, the trial was stopped.

On second trial the 15 shots were fired in 31 seconds, magazine loaded and its 5 cartridges fired in 10 seconds; total, 41 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-seven shots were fired.

(*c*) *As magazine arm for 1 minute.*—Twenty-eight shots were fired; 1 cartridge left in chamber and 1 in magazine.

III. ENDURANCE.

(*a*) *As magazine arm for 500 rounds.*—Mechanism worked well, except that considerable difficulty was experienced in stripping cartridges from the loading clip to the magazine.

(*b*) *As single loader for 100 rounds.*—Gun worked well.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted; mechanism worked well.

(*b*) *Magazine loaded when exposed.*—Well dusted; mechanism worked well.

V. DEFECTIVE CARTRIDGES.

The first defective broke the collar which secures the extractor to the bolt; bolt could not be opened.

Test suspended.

No. 28.—Krag-Jörgensen No. 5.

SAFETY TEST.

The gun was operated by Mr. E. Jörgensen and fired from the shoulder, 10 shots in 32 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were fired as a single loader in 44 seconds, the 5 from the magazine in 10 seconds; total, 54 seconds; 16 hits.

(*b*) *As single loader for 2 minutes.*—Thirty-eight shots were fired and 1 cartridge introduced into chamber; 35 hits.

(*c*) *As magazine arm for 2 minutes.*—Forty-three shots were fired and 1 cartridge left in chamber, with 38 hits. In charging the magazine but four cartridges were introduced on one occasion.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as single loader in 32 seconds, the 5 from the magazine in 7 seconds; total, 39 seconds.

(*b*) *As single loader for 1 minute.*—On first trial, after 9 shots had been fired in 22 seconds, the tenth cartridge, in some manner not fully understood, was so placed in the receiver as to be thrown out to the right as the bolt was pushed forward, at the same time raising and slightly rotating the extractor. On the second trial this again occurred with the second cartridge. On the third trial 29 shots were fired, of which 1 missed fire.

(*c*) *As magazine arm for 1 minute.*—Thirty-five shots were fired, and 1 cartridge from the eighth packet introduced into the magazine.

III. ENDURANCE.

(*a*) *As magazine arm for 500 rounds.*—Breech and magazine mechanism worked well and easily in all particulars.

(*b*) *As single loader for 100 rounds.*—Mechanism worked well and easily in all particulars.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Thoroughly dusted. Mechanism worked easily.

(*b*) *Magazine loaded when exposed.*—Thoroughly dusted. First cartridge from magazine not fed into receiver until point of bullet freed by hand; mechanism then worked well.

V. DEFECTIVE CARTRIDGES.

No injury whatever to mechanism from the three forms of defectives. Gun worked well.

VI. EXCESSIVE CHARGES.

Bolt opened easily; mechanism worked well and freely.

VII. EASE OF MANIPULATION.

Satisfactory.

SUPPLEMENTARY TESTS.

I. DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—Gun worked in a satisfactory manner. No injury whatever to mechanism from defective cartridges.

(*b*) *As a magazine arm.*—Gun very dry; worked rather stiffly. No injury whatever to mechanism from defectives.

II. RUST.

Gun very thorougly rusted; neither bolt nor magazine gate could be opened by hand; only light blows, though, of mallet required; magazine mechanism then worked well; light blows of mallet required to

operate bolt for first three shots; afterwards operated by hand, though with difficulty. On conclusion of test, without removing rust, mechanism was oiled without dismounting; all parts then worked very easily.

III. EXPLOSIONS IN MAGAZINE.

Very improbable that they could occur.

IV. DISMOUNTING AND ASSEMBLING.

Can be accomplished very quickly and easily, without the aid of any tools.

ADDITIONAL TEST.

To determine the average rapidity of fire of this arm in the hands of instructed but not particularly expert soldiers, three men of the ordnance detachment at Springfield Armory, one of whom had served a previous enlistment in the Marine Corps, U. S. Navy, one in the Tenth United States Infantry, and one in the Second United States Cavalry, fired with aim 20 shots at an A target, at a range of 100 yards. Before commencing firing the magazine was charged and put in reserve. Commencing firing, 15 shots were delivered as a single loader, loading from the cartridge belt, in 1 minute and 24 seconds. The magazine was then turned on and its 5 cartridges fired in 26 seconds. Total for the 20 shots, 1 minute and 50 seconds (average time for the three men).

A similar test was then made by the recorder of the board, who fired the 15 shots as a single loader in 55 seconds, turned on the magazine, and fired its 5 cartridges in 10 seconds. Total for the 20 shots, 1 minute and 5 seconds.

No. 29.—KRAG-JÖRGENSEN NO. 6.

SAFETY TEST.

The gun was operated by Mr. E. Jörgensen and fired from the shoulder, 10 shots in 27 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were fired as a single loader in 45 seconds, the 5 from the magazine in 9 seconds; total, 54 seconds; 1 miss-fire, 16 hits.

(*b*) *As single loader for 2 minutes.*—Forty-two shots were fired; 41 hits.

(*c*) *As magazine arm for 2 minutes.*—Forty-six shots were fired and 1 cartridge left in chamber and 3 in magazine, with 39 hits.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as single loader in 30 seconds, the 5 from the magazine in 7 seconds; total, 37 seconds; 1 miss-fire.

(*b*) *As single loader for 1 minute.*—Twenty-seven shots were fired; one other cartridge not properly introduced by operator and thrown out of receiver when closing the bolt.

(*c*) *As magazine arm for 1 minute.*—Thirty-seven shots were fired and 1 cartridge left in magazine; 1 miss-fire; operator twice charged magazine with only 4 cartridges.

III. ENDURANCE.

(*a*) *As magazine arm for 500 rounds.*—Breech and magazine mechan ism worked well and easily in all particulars.

(*b*) *As single loader for 100 rounds.*—Mechanism worked well and easily.

On examination of the 5 cartridges kept in the magazine during the firing, it was observed that the bullets had settled down in the case from 0.1″ to 0.2″, there being more than that air space originally between bullet and powder and the case being not crimped on the bullet.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Thoroughly dusted; mechanism worked easily.

(*b*) *Magazine loaded when exposed.*—Thoroughly dusted; worked easily and well.

V. DEFECTIVE CARTRIDGES.

No injury whatever to mechanism from the three forms of defectives; gun worked well.

VI. EXCESSIVE CHARGES.

On first shot the empty shell was not extracted; did not fail on other shots; bolt opened easily and worked well.

VII. EASE OF MANIPULATION.

Satisfactory.

SUPPLEMENTARY TESTS.

I. DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—Gun worked in a satisfactory manner; no injury whatever to mechanism from defective cartridges.

(*b*) *As a magazine arm.*—Gun very dry; worked rather stiffly; no injury whatever to mechanism from defectives.

II. RUST.

Gun very thoroughly rusted; magazine gate opened easily; magazine mechanism worked well; bolt required light blows from a mallet before it could be opened; afterwards worked well, but very stiffly.

III. EXPLOSIONS IN MAGAZINE.

Very improbable that they could occur.

IV. DISMOUNTING AND ASSEMBLING.

Can be accomplished very quickly and easily without the aid of any tools.

ADDITIONAL TEST.

To determine the average rapidity of fire of this arm in the hands of instructed but not particularly expert soldiers, three men of the ordnance detachment at Springfield Armory, one of whom had served a previous enlistment in the Marine Corps, U. S. Navy, one in the Tenth United States Infantry, and one in the Second United States Cavalry, fired with aim 20 shots at an A target, at a range of 100 yards. Before commencing firing the magazine was charged and put in reserve. Commencing firing, 15 shots were delivered as a single loader, loading from the cartridge belt, in 1 minute and 28 seconds. The magazine was then turned on and its five cartridges fired in 22 seconds. Total for the 20 shots, 1 minute and 50 seconds (average time for the three men).

No. 30.—Ford.

SAFETY TEST.

The gun was operated by the inventor, Mr. John Ford, of Portneuf, Province of Quebec, Canada. The empty shell from the first shot was extracted but not ejected; on the second shot the extractor lifted over the head, leaving the cartridge shell in the chamber; it was removed with a ramrod. On the third shot there was the same failure to extract. Gun then withdrawn by the inventor.

No. 31.—Hampden No. 1.

SAFETY TEST.

The gun was operated by the inventor, Mr. Thomas B. Wilson, of Springfield, and by Mr. Allen Webster, and fired from the shoulder, 10 shots in 55 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were fired as a single loader in 45 seconds, the magazine turned on and its cartridges fired in 11 seconds; total, 56 seconds; 19 hits.

(*b*) *As single loader for 2 minutes.*—Forty-one shots were fired; 35 hits.

(*c*) *As magazine arm for 2 minutes.*—Forty-five shots were fired, with 39 hits and 4 cartridges left in magazine. One cartridge was not fed down from magazine to receiver and was removed with cartridge packet.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as a single loader in 29 seconds, the 5 from the magazine in 7 seconds; total, 36 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-six shots were fired.

(*c*) *As magazine arm for 1 minute.*—On the eleventh shot the front locking lug on bolt broke (apparently due to defect in the metal), but as bolt was secured by rear locking mass it was not blown back. Time not taken. Gun disabled.

No. 32.—Durst No. 1.

SAFETY TEST.

The gun was operated by the inventor, Mr. M. H. Durst, of Wheatlands, Cal. On the first trial 6 shots were fired in 28 seconds, when, the claw of the extractor impinging against primers which had settled in extractor recess of the breech casing, the bolt could not be closed, the extractor being sprung in the effort.

On second trial, with new extractor, the 10 shots were fired in 55 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 10 cartridges, it was endeavored to first fire 10 shots as a single loader, then those from the magazine.

On first trial, after 4 shots had been fired, the loose primers settling in extractor recess, prevented closing of bolt.

On second trial, after third shot, the extractor tore over cartridge head, leaving empty shell in chamber.

On third trial the same failure to extract again occurred after the third shot.

On the fourth trial the 10 shots as single loader were fired in 1 minute and 24 seconds; the 10 from the magazine in 41 seconds; total, 2 minutes and 5 seconds; 20 hits.

During the firing there were 3 failures to extract (empty shell removed with ramrod), and 4 instances where the cartridge head so cracked as to cause escape of gas into operator's face.

Gun withdrawn by permission of the board.

No. 33.—Larsen.

SAFETY TEST.

The gun was operated by the inventor, Mr. Ivert Larsen, of Chicago, Ill., and fired ten shots from the shoulder in 44 seconds.

One miss-fire; exploded on second trial.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were first fired as a single loader in 1 minute and 18 seconds; the magazine then turned on and its cartridges fired in 22 seconds; total, 1 minute and 40 seconds; 19 hits. On one occasion, when closing the bolt, the cocking piece slipped past the nose of the sear; cartridge not exploded; piece recocked and fired.

(*b*) *As single loader for 2 minutes.*—Twenty-five shots were fired, with 25 hits. During the firing the nut at end of cocking piece unscrewed and fell to the ground.

(*c*) *As magazine arm for 2 minutes.*—On first trial 10 shots were fired, with 9 hits, in 1 minute and 10 seconds, when the operator inadvertently drew back the bolt, bringing a second cartridge into the receiver before the previous had been quite pushed into the chamber. A jam, of course, resulted.

On second trial 20 shots were fired, with 15 hits, and 5 cartridges (its capacity) left in the magazine.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as single loader were fired in 1 minute, the 5 from the magazine in 20 seconds; total, 1 minute 20 seconds.

Firing delayed by necessity of picking up and screwing on nut of cocking piece.

(*b*) *As single loader for 1 minute.*—Twenty shots were fired and 1 cartridge left in chamber. Nut of cocking piece nearly off.

(*c*) *As magazine arm for 1 minute.*—Ten shots were fired and 5 left in magazine.

III. ENDURANCE.

(*a*) *As magazine arm for 500 rounds.*—Test, as usual, conducted in sets of 50 rounds; towards the close of each the mechanism, becoming dry and hot, worked with increasing stiffness, and near close of test bolt could be opened only by reversing gun and lifting on operating lever.

(*b*) *As single loader for 100 rounds.*—Mechanism worked only with much difficulty.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted; considerable exertion required to turn on magazine; entire mechanism worked with extreme difficulty.

(*b*) *Magazine loaded when exposed.*—Experience same as in first portion of test.

V. DEFECTIVE CARTRIDGES.

On the first defective cartridge the extractor was blown over the head of the cartridge and so buckeled up as to prevent opening of bolt. The bottom of the magazine box was blown out and the sides torn apart and separated. Gun disabled.

No. 34.—Miles.

SAFETY TEST.

The gun was operated by the inventor, Mr. Don D. Miles, of Aurora, Ill., and fired from the shoulder 10 shots in 1 minute and 32 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 9 cartridges, it was endeavored to first fire 11 shots as a single loader. After 2 shots had been fired in about 5 minutes, occasioned by the extreme difficulty in pulling the trigger and operating the mechanism, when opening the bolt after the second shot the interior lever moving the feed trough or block was broken, disabling the gun.

Arm then withdrawn by the inventor.

No. 35.—Savage No. 1.

SAFETY TEST.

The gun was operated by the inventor, Mr. Arthur Savage, and fired 10 shots from the shoulder in 26 seconds. One miss-fire.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The full capacity of the magazine was 9 cartridges, but the cartridge packets holding but 6 cartridges and the introduction of a greater number into the magazine being attended with some difficulty, the test was conducted with that number only. Fourteen shots were therefore fired as a single loader in 55 seconds, the 6 from the magazine in 13 seconds; total, 1 minute and 8 seconds; 14 hits. There were 4 miss-fires, due, probably, to operator's failure to entirely close and lock the operating lever.

(*b*) *As single loader for 2 minutes.*—Thirty-six shots were fired, with 31 hits. One miss-fire; lever probably not fully closed.

(*c*) *As magazine arm for 2 minutes.*—Twenty-four shots were fired, with 24 hits, and 2 cartridges additional introduced into magazine.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 14 shots were fired in 36 seconds, the 6 from the magazine in 7 seconds; total, 43 seconds.

(*b*) *As single loader for 1 minute.*—After 3 shots had been fired the last empty shell was extracted with much difficulty and the lever could not be so operated as to introduce the fourth cartridge. Partly dismounting the gun it was found the breechblock was broken. Gun withdrawn.

No. 36—Mullins.

SAFETY TEST.

The gun was operated by the recorder of the board and fired 10 shots from a fixed rest with a lanyard. Time not taken.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun being without cut-off and holding but 3 cartridges in the magazine, 17 shots were first fired as a single loader in 1 minute and 45 seconds; the magazine then charged and its 3 cartridges fired in 17 seconds; total, 1 minute and 52 seconds; 18 hits.

(*b*) *As single loader for 2 minutes.*—Twenty-seven shots were fired, with 27 hits.

(*c*) *As magazine arm for 2 minutes.*—Seven shots were fired with 7 hits and 2 cartridges left in magazine. The ejector always, the extractor for all but one shot, failed to work, and it was necessary to pick out the empty shell by hand. If the breechblock was opened with such force as to operate the extractor, the upper cartridge from the magazine rose in front of the empty shell and prevented its removal.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 17 shots as a single loader in 1 minute and 18 seconds, the magazine charged and its 3 cartridges fired in 27 seconds; total, 1 minute and 45 seconds. Same difficulty with extraction and ejection as in previous part of test.

Thumb piece frequently did not close without special pressure. Stock around magazine badly cracked and split. Test suspended.

No. 37.—Chaffee-Reece

SAFETY TESTS.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 29 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were first fired as a single loader in 44 seconds; the magazine was then turned on and its 5 cartridges fired in 15 seconds; total, 50 seconds; 17 hits. There was 1 miss-fire, due to primer of one of the cartridges in the magazine coming out of pocket before the cartridge was fed into the chamber.

(*b*) *As single loader for 2 minutes.*—Forty-four shots were fired, with 38 hits.

(*c*) *As magazine arm for 2 minutes.*—Twenty shots were fired, with 19 hits.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as single loader in 36 seconds, the magazine turned on and its 5 cartridges fired in 8 seconds; total, 44 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-seven shots were fired.

(*c*) *As magazine arm for 1 minute.*—Nine shots were fired (the operator once charging the magazine with but 4 instead of 5 cartridges), and 5 cartridges introduced into magazine.

III. ENDURANCE.

As a magazine arm for 500 rounds.—On the one hundred and twenty-fifth shot the overhang of cocking piece was broken, preventing further use of the gun.

No. 38.—Blake No. 1.

SAFETY TEST.

The gun was operated by the inventor, Mr. John H. Blake, of New York, N. Y., and fired from the shoulder, 10 shots in 40 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 7 cartridges, 13 shots were first fired as a single loader in 57 seconds; the magazine then turned on and its cartridges fired in 23 seconds; total, 1 minute and 20 seconds; 15 hits.

During magazine fire the magazine packet on three occasions so far revolved as to pass the cartridges beyond the reach of the bolthead, and a second motion, back and forward, of the bolt became necessary.

(*b*) *As single loader for 2 minutes.*—Twenty-eight shots were fired, with 27 hits, and 1 cartridge left in chamber. There were 2 failures to eject.

(*c*) *As magazine arm for 2 minutes.*—The first packet was introduced and its 7 cartridges fired in 19 seconds; a second packet introduced and 1 cartridge fired, when the cartridge packet repeatedly revolving too far a second cartridge was not left in front of the bolt. On second trial, these failures repeatedly occurred with the first cartridge packet.

On third trial, the test was continued during the 2 minutes, 15 shots being fired, with 14 hits, and 1 cartridge fed into chamber. To feed, then, 16 cartridges from the magazine to the chamber, it was necessary, in consequence of the packet generally revolving too far, to operate the mechanism 108 times.

II. RAPIDITY AT WILL.

(a) As single loader and then as repeating arm for contents of magazine.—The 13 shots as a single loader in 44 seconds, 6 shots from the

magazine in 16 seconds; total, 1 minute; operator, thinking the magazine empty, then ceased firing. There were 2 failures to feed cartridges, owing to packet revolving too far.

(b) As single loader for 1 minute.—Eighteen shots were fired and 1 cartridge introduced into chamber.

(c) As magazine arm for 1 minute.—Six shots were fired and 1 other cartridge missed fire. Repeated failures to feed, due to cartridge packet revolving past the bolthead. Gun then withdrawn by inventor for alteration of cartridge packets.

No. 39.—Lee No. 3.

SAFETY TEST.

The gun was operated by Mr. J. P. Lee and fired from the shoulder, 10 shots in 37 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(a) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 10 cartridges, that number were first fired as a single loader in 45 seconds; the magazine then turned on and its cartridges fired in 34 seconds; total, 1 minute and 19 seconds; 20 hits.

(b) *As single loader for 2 minutes.*—Forty-three shots were fired, with 37 hits.

(c) *As magazine arm for 2 minutes.*—Forty-five shots were fired, with 41 hits, and 5 cartridges left in the magazine.

II. RAPIDITY AT WILL.

(a) *As single loader and then as repeating arm for contents of magazine.*—After 5 shots had been fired the cut-off, under the influence of the jar of recoil, moved, turning on the magazine. On second trial this again occurred after the sixth shot. A slight alteration was then made to cut-off and test resumed.

On third trial the 10 shots as a single loader were fired in 19 seconds, the magazine turned on and its cartridges fired in 11 seconds; total, 30 seconds.

(b) *As single loader for 1 minute.*—Twenty-four shots were fired.

(c) *As magazine arm for 1 minute.*—Thirty-nine shots were fired and 10 cartridges introduced into magazine.

III. ENDURANCE.

(a) *As a magazine arm for 500 rounds.*—There were several miss-fires, and 2 failures to extract. In all other particulars test was satisfactory.

(b) *As single loader for 100 rounds.*—Mechanism worked well.

IV. DUST.

(a) *Magazine empty when exposed.*—Mechanism worked well.

(b) *Magazine loaded when exposed.*—Mechanism worked well.

V. DEFECTIVE CARTRIDGES.

No injury to mechanism from three forms of defectives.

VI. EXCESSIVE CHARGES.

Mechanism worked well.

VII. EASE OF MANIPULATION.

Satisfactory.

SUPPLEMENTARY TESTS.

I DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—By the first defective cartridge the extractor and its shield were blown off, disabling the gun. After repairs the fifth regular test (that for defective cartridges) was repeated without injury to the mechanism; the first supplementary test was then resumed and completed.

Mechanism worked well.

(*b*) *As a magazine arm.*—Mechanism worked stiffly but well.

II. RUST.

Gun thoroughly rusted. Required a mallet to open bolt, and the use of mallet after every shot to manipulate it. Otherwise worked all right.

III. EXPLOSIONS IN MAGAZINE.

Very improbable that any should occur.

ADDITIONAL TEST.

To determine the average rapidity of fire of this arm in the hands of instructed but not particularly expert soldiers, three men of the ordnance detachment at Springfield Armory, one of whom had served a previous enlistment in the Marine Corps, U. S. Navy, one in the Tenth United States Infantry, and one in the Second United States Cavalry, fired with aim 20 shots at an A target, at a range of 100 yards. Before commencing firing the magazine was charged and put in reserve. Commencing firing, 10 shots were delivered as a single loader, loading from the cartridge belt, in 1 minute and 5 seconds. To turn on the magazine required 17 seconds, and to fire its 10 cartridges, 1 minute and 2 seconds. Total for the 20 shots, 2 minutes and 24 seconds (average time for the three men).

In the trial of this gun the firing pin, after the trigger had been pulled, caught 5 times at the half-cock notch, requiring a separate cocking of the gun before it could be fired.

No. 40.—HAMPDEN No. 2.

SAFETY TEST.

The gun was operated by Mr. T. B. Wilson and fired from the shoulder, 10 shots in 50 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were first fired as a single loader in 54 seconds; the magazine turned on and its 5 cartridges fired in 15 seconds; total, 1 minute and 9 seconds; 20 hits.

(*b*) *As a single loader for 2 minutes.*—Forty-five shots were fired, with 35 hits.

(*c*) *As magazine arm for 2 minutes.*—First trial, the first cartridge from second packet jammed. On second trial a cartridge hung a little in feeding from the second packet and the first from the third packet jammed. On third trial the seventh packet jumped out of the magazine after second shot had been fired from it. Time for this third trial, 1 minute and 45 seconds; 36 shots; 31 hits.

On fourth trial the first cartridge from the second packet was not fed into receiver.

On fifth trial this occurred with the third cartridge from the first packet.

On sixth trial the test was completed, 50 shots (one a miss-fire) being fired, with 38 hits. Inventor claimed that the failure to feed was mainly chargeable to the packets and to the material employed in their construction.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as a single loader in 29 seconds, 5 seconds for those from magazine; total, 34 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-seven shots were fired, of which 2 were miss-fires.

(*c*) *As magazine arm for 1 minute.*—Thirty shots were fired and 5 cartridges introduced into magazine.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—Mechanism worked well.

(*b*) *As single loader for 100 rounds.*—Worked well, except that there were several miss-fires.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Gun worked well.

(*b*) *Magazine loaded when exposed.*—Gun worked well.

V. DEFECTIVE CARTRIDGES.

No injury whatever to mechanism from three forms of defectives.

VI. EXCESSIVE CHARGES.

Mechanism worked freely and well.

VII. EASE OF MANIPULATION.

Satisfactory to the board.

SUPPLEMENTARY TESTS.

I. DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—After first dusting there were 2 failures to extract, extractor overriding cartridge head. No injury to mechanism from defectives.

(*b*) *As a magazine arm.*—After first dusting there were, as before, 2 failures to extract. No injury from defectives.

II. RUST.

Mechanism thoroughly rusted. Bolt opened with mallet. Firing pin rusted fast. Gun could not be fired.

III. EXPLOSIONS IN MAGAZINE.

Very improbable that they should occur.

ADDITIONAL TEST.

To determine the average rapidity of fire of this arm in the hands of instructed but not particularly expert soldiers, three men of the ordnance detachment at Springfield Armory, one of whom had served a previous enlistment in the Marine Corps, U. S. Navy, one in the Tenth United States Infantry, and one in the Second United States Cavalry, fired with aim 20 shots at an A target, at a range of 100 yards. Before commencing firing the magazine was charged and put in reserve. Commencing firing, 15 shots were delivered as a single loader, loading from the cartridge belt, in 1 minute and 35 seconds. The magazine was then turned on, and its 5 cartridges fired in 26 seconds. Total for the 20 shots, 2 minutes and 1 second (average time for the three men).

No. 41.—Russell-Livermore No. 1.

SAFETY TEST.

The gun was operated by Capt. A. H. Russell, Ordnance Department, U. S. Army, and fired 10 shots from the shoulder in 34 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were first fired as a single loader in 54 seconds, the magazine then turned on and its cartridges fired in 10 seconds; total, 1 minute and 4 seconds. One miss-fire, 19 hits.

(*b*) *As a single loader for 2 minutes.*—Thirty-seven shots were fired, with 30 hits and 1 cartridge left in chamber.

(*c*) *As magazine arm for 2 minutes.*—On the first trial, after 15 shots had been fired with 9 hits, after the fourth packet had been introduced in the magazine, operator could not draw through the clip, leaving the mechanism blocked.

On second trial, after 25 shots had been fired with 22 hits, the sixth clip stuck as before, blocking mechanism.

On third trial 31 shots were fired, 3 cartridges left in magazine and 1 in chamber; 25 hits. Difficulty experienced in every instance in drawing out cartridge clips.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as a single loader in 35 seconds, those from the magazine in 15 seconds; total, 50 seconds.

(*b*) *As single-loader for 1 minute.*—Eighteen shots were fired and 1 cartridge left in chamber.

(*c*) *As magazine arm for 1 minute.*—On the first trial the first clip could not be withdrawn; no shots fired.

On second trial the last cartridge from the first magazine fed up too far; mechanism jammed.

On the third trial, the magazine casing now working loose, the cartridges were not properly fed, and the bolt jammed after the second shot.

On fourth trial this jam again occurred after the third shot.

The gun was then withdrawn by the inventors for repairs. When again submitted the tests were resumed at the same stage. On fifth trial of this test, after 12 shots had been fired in 28 seconds, a failure to eject occurred and the operator inadvertently closing bolt, a jam occurred.

On sixth trial 29 shots were fired and 1 cartridge left in magazine.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—Mechanism worked well.
(*b*) *As single loader for 100 rounds.*—Mechanism worked well.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted; worked fairly well.
(*b*) *Magazine loaded when exposed.*—Well dusted; magazine lever did not work well; fourth cartridge failed to feed.

V. DEFECTIVE CARTRIDGES.

By the first defective the stock surrounding the magazine was split, the extractor spring broken, and the walls of the magazine so bent and spread that the bolt could not be revolved; gun disabled.

No. 42—Russell-Livermore No. 2.

SAFETY TEST.

The gun was operated by Capt. A. H. Russell, Ordnance Department, U. S. Army, and fired 10 shots from the shoulder in 33 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Immediately after test was commenced the gun was withdrawn by the inventors for a slight correction of the mechanism. When resubmitted the test was resumed. The magazine holding 5 cartridges, it was endeavored to first fire 15 shots as a single loader, then those from the magazine. On the first trial 19 shots in all were fired; 1 cartridge thrown from magazine by the recoil of the gun; time not taken.

On second trial, after 1 shot had been fired, a cartridge was thrown out of the magazine.

On third trial this again occurred. On fourth trial this again occurred, but continuing the test the 15 shots as a single loader were fired with 15 hits in 46 seconds; the magazine (then having in it but 4 cartridges) was then turned on, when its first cartridge failed to properly feed up, causing a jam of the mechanism.

On the fifth trial the lower cartridge from the magazine was thrown out as before by the shock of the first discharge of the gun; continuing the test, however, the 15 shots as single loader were fired in 42 seconds; the magazine turned on, and its 4 remaining cartridges fired in 10 seconds; total, 52 seconds; 16 hits.

(*b*) *As a single loader for 2 minutes.*—Thirty-five shots were fired, with 32 hits, and 1 cartridge left in chamber.

(*c*) *As magazine arm for 2 minutes.*—After the third shot the magazine failed to feed, due to the operator placing his fingers on the feed lever; an accident very likely to occur.

On the second trial this again occurred after the fourth shot.

On the third trial this again occurred after the second shot, the cartridge partly feeding up, jamming the mechanism.

On the fourth trial this again occurred exactly as in the third trial. On the fifth trial, the operator exercising unusual care, 35 shots were fired, with 31 hits. There were four miss-fires.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 shots as single loader were fired in 34 seconds, the lower cartridge from the magazine jumping out as in previous cases. After 2 of the 4 cartridges then remaining in magazine had been fired, the third was not properly fed up, causing a jam.

On second trial, the 15 shots as single loader were fired in 32 seconds, during which the lower cartridge from magazine had jumped out as in previous instances; the magazine was then turned on, and the 4 cartridges remaining therein fired in 12 seconds; total for the 19 shots, 44 seconds.

(*b*) *As single loader for 1 minute.*—On first trial, after the first shot the half-cock notch of cocking piece caught on the point of the sear.

On second trial 25 shots were fired; a delay was once occasioned by cocking piece catching as before; was freed by operator.

(*c*) *As magazine arm for 1 minute.*—On the first trial, after 4 shots had been fired, a blown-out primer falling into the magazine caused a jam.

On second trial, after 1 shot had been fired, failure to properly feed from the magazine caused a jam.

On third trial this jam again occurred after the second shot.
On fourth trial the jam occurred again after the eleventh shot.
On fifth trial the test was completed, 18 shots being fired, during which the jam twice occurred and was freed by operator. There was 1 miss-fire.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—As when the magazine was charged with 5 cartridges, its proper number, the lower one was always thrown out by the shock of the first discharge, the test was conducted with only 4 cartridges to a magazine. Difficulty in extraction frequently experienced; otherwise mechanism worked well. Five miss-fires.
(*b*) *As single loader for 100 rounds.*—Test conducted with only 4 cartridges in reserve in magazine. Mechanism worked fairly well.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Well dusted; worked stiffly.
(*b*) *Magazine loaded when exposed.*—Well dusted; worked with difficulty.

V. DEFECTIVE CARTRIDGES.

No injury to mechanism from three forms of defectives.

VI. EXCESSIVE CHARGES.

Test omitted.

VII. EASE OF MANIPULATION.

Not satisfactory; great care required to properly operate magazine.

SUPPLEMENTARY TESTS.

I. DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—By the first defective the extractor cover was blown out and the extractor broken. The magazine spring broken and the housing of magazine torn off; gun disabled.

No. 43.—Savage No. 2.

SAFETY TEST.

The gun was operated by the inventor, Mr. Arthur Savage, and fired 10 shots from the shoulder in 25 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The full capacity of the magazine was 9 cartridges. The gun has no cut-off, but by continually firing the upper cartridge from the magazine and recharging a single-loading fire can be maintained with 8 cartridges held in reserve in the magazine. Conducting the test in

this manner the 12 shots were fired in 40 seconds, the 8 from the magazine in 15 seconds; total, 55 seconds; 16 hits.

(*b*) *As a single loader for 2 minutes.*—Thirty-four shots were fired, with 24 hits,

(*c*) *As magazine arm for 2 minutes.*—The loading packets holding but 6 cartridges, only that number were introduced when charging the magazine. The stiffness of the magazine spring would increase the difficulty of charging with the full magazine capacity. Thirty-five shots were fired and 1 cartridge left in chamber; 23 hits.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Trial conducted as for corresponding portion of first regular test. The 12 shots as a single loader in 40 seconds, the 8 from the magazine in 21 seconds; total, 1 minute and 1 second.

(*b*) *As single loader for 1 minute.*—Twenty-six shots were fired and 1 cartridge introduced in chamber; 1 miss-fire.

(*c*) *As magazine arm for 1 minute.*—Twenty-three shots were fired. One cartridge dropped in charging magazine.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—Mechanism worked well, but rather stiffly.

(*b*) *As single loader for 100 rounds.*—Mechanism worked well, but rather stiffly.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Thoroughly dusted. Mechanism worked very stiffly.

(*b*) *Magazine loaded when exposed.*—Thoroughly dusted. After opening breechblock could not be closed; mechanism operated with great difficulty.

Dismounting gun and removing adhering dust, the test was completed.

V. DEFECTIVE CARTRIDGES.

Extractor slightly sprung by defectives; otherwise no injury to mechanism.

VI. EXCESSIVE CHARGES.

Mechanism worked stiffly; extractor failed to withdraw empty shell.

VII. EASE OF MANIPULATION.

Manipulation not well adapted for a military arm.

No. 44.—Fogerty.

SAFETY TEST.

The gun was operated by the inventor, Mr. George Fogerty, of Cambridgeport, Mass., and fired 10 shots from the shoulder in 1 minute and 13 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The magazine holding 6 cartridges it was endeavored to first fire 14 shots as a single loader and then the contents of the magazine. On the first trial, after 4 shots had been fired in 1 minute and 2 seconds, the upper cartridge from the magazine rose enough in front of the bolt to jam the mechanism.

On second trial the 14 shots as a single loader were fired in 1 minute and 38 seconds; the magazine then turned on, and its 6 cartridges fired in 1 minute and 8 seconds; total, 2 minutes and 46 seconds; 11 hits.

Further tests were then discontinued by the board.

No. 45.—DURST No. 2.

SAFETY TEST.

The gun was operated by the inventor, Mr. M. H. Durst, and fired 10 shots from the shoulder in 46 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 10 cartridges, it was endeavored to first fire 10 shots as a single loader and then the 10 from the magazine.

On the first trial, after 4 shots had been fired, the cartridge primer remaining in the locking-lug recess jammed the mechanism.

On the second trial, after 3 shots had been fired in 19 seconds, a jam again occurred from the same cause.

On the third trial, after the first shot the bolt jammed again.

On the fourth trial, after 7 shots had been fired in 44 seconds, with 4 hits, the extractor overrode head of cartridge, leaving the last empty shell in the gun.

On the fifth trial the 10 shots as a single loader were fired in 1 minute, the magazine turned on, and 1 shot fired in 15 seconds; total for the 11 shots, 1 minute and 15 seconds; the second cartridge from the magazine then jammed, as in former instances, due to blowing out of cartridge primers. During this firing the forestock of the gun had separated, worked forward, and partly turned. The primers also, in the proportion of about 3 to every 4 shots, had come out, causing a blow back of gas in the face of the operator. The ammunition being manifestly dangerous and the further test of the gun with it being not merely unsatisfactory but, in the opinion of the board, unsafe, the trial was discontinued.

Later, when dismounting the gun, it was discovered that the pin retaining the firing pin and cocking piece in the body of the bolt was broken. This break must have been occasioned by the last shot, as by its absence there was nothing to retain these parts in the bolt, and a blow back of gas would probably have driven them into the operator's face.

No. 46.—MAUSER No. 5.

SAFETY TEST.

The gun was operated by Mr. Alfons Mauser and fired 10 shots from the shoulder in 26 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 5 cartridges, 15 shots were first fired as a single loader in 42 seconds; the magazine then turned on, and its 5 cartridges fired in 10 seconds; total, 52 seconds; 19 hits.

(*b*) *As a single loader for 2 minutes.*—Forty-six shots were fired, with 44 hits.

(*c*) *As magazine arm for 2 minutes.*—Forty-seven shots were fired, with 47 hits and 3 cartridges left in magazine.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 15 cartridges as a single loader in 33 seconds, the 5 from the magazine in 9 seconds; total, 42 seconds.

(*b*) *As single loader for 1 minute.*—Twenty-seven shots were fired.

(*c*) *As magazine arm for 1 minute.*—Thirty-three shots were fired and 2 cartridges left in the magazine.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—Mechanism worked well and easily.

(*b*) *As single loader for 100 rounds.*—Mechanism worked well and easily.

IV. DUST.

(*a*) *Magazine empty when exposed.*—Thoroughly dusted. Bolt worked throughout with great difficulty; the second cartridge from the magazine not fed up; removing bolt and tapping magazine box with mallet so loosened cartridges as to allow firing on retrial.

(*b*) *Magazine loaded when exposed.*—Bolt worked rather smoother than on first portion of test. The third cartridge from magazine not fed up until bolt had been manipulated three times.

V. DEFECTIVE CARTRIDGES.

No injury whatever to mechanism from three forms of defectives.

VI. EXCESSIVE CHARGES.

Test omitted.

VII. EASE OF MANIPULATION.

Satisfactory.

SUPPLEMENTARY TESTS.

I. DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—By the second defective cartridge the ejector spring was so set as to fail to work. In all subsequent shots the empty shell was not ejected. Otherwise mechanism worked well.

(*b*) *As a magazine arm.*—In consequence of the set of the ejector spring the empty shells were not thrown out after firing. After dusting with magazine full, 3 of the 5 cartridges were not fed up into receiver until after several motions of the bolt. Otherwise mechanism worked well.

II. RUST.

Well rusted; opened stiffly, but worked well.

III. EXPLOSIONS IN MAGAZINES.

Very improbable they should occur.

ADDITIONAL TEST.

To determine the average rapidity of fire of this arm in the hands of instructed but not particularly expert soldiers three men of the ordnance detachment at Springfield Armory, one of whom had served a previous enlistment in the Marine Corps, U. S. Navy, one in the Tenth United States Infantry, and one in the Second United States Cavalry, fired with aim 20 shots at an A target, at a range of 100 yards. Before commencing firing the magazine was charged and put in reserve; commencing firing, 15 shots were delivered as a single loader, loading from the cartridge belt, in 1 minute and 29 seconds; the magazine was then turned on and its 5 cartridges fired in 23 seconds; total for the 20 shots. 1 minute and 52 seconds (average time for the three men).

No. 47.—Blake No. 2.

SAFETY TEST.

Test omitted, the gun having previously been fired.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—Test omitted.

(*b*) *As a single loader for 2 minutes.*—Test omitted.

(*c*) *As magazine arm for 2 minutes.*—After 9 shots had been fired (2 miss-fires) with 7 hits in 44 seconds, the extractor overrode cartridge head leaving last empty shell in the gun.

On second trial the failure to extract occurred after the first shot.

The board deemed further trials unnecessary.

No. 48.—Rubin.

SAFETY TEST.

Test omitted.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The capacity of the magazine being 6 cartridges, 14 shots were first fired as a single loader in 55 seconds; the magazine then turned on and its cartridges fired in 19 seconds; total, 1 minute and 14 seconds; 1 miss-fire, 17 hits. One cartridge not fed up from magazine until the motion of bolt had been repeated.

(*b*) *As a single-loader for 2 minutes.*—Test omitted.

(*c*) *As magazine arm for 2 minutes.*—Twenty-seven shots were fired with 27 hits. One cartridge not properly fed up from magazine and jammed when closing bolt.

Ammunition suitable for this gun being exhausted, further tests were omitted.

No. 49.—Schulhof, Model 1888.

This arm having previously been fully tested and the results published in the report of the Chief of Ordnance for 1889, and there being, furthermore, no suitable ammunition available for additional trial, it was merely examined by the board, but not fired.

No. 50.—Kelton.

SAFETY TEST.

The gun was fired by Mr. R. T. Hare for the board; time not taken.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The quick loader holding 10 cartridges, it was attached with that number by its clasp to the gun, while 10 shots were fired as a single loader. On the tenth shot (time, 52 seconds, 10 hits) the clasp broke, the quick-loader packet falling to the ground.

The securing attachment was then repaired and test repeated on a subsequent day, the 10 shots, as a single loader, being fired in 53 seconds, the 10 shots from the quick loader in 57 seconds; total for the 20 shots, 1 minute and 50 seconds; 18 hits.

(*b*) *As single loader for 2 minutes.*—Twenty-six shots were fired with 25 hits.

(*c*) *As magazine arm for 2 minutes.*—Quick-loading packet charged with cartridges, attached to gun, and 2 shots fired (with 2 hits) in 34 seconds.

On this second shot the clasp securing packet to gun again broke. After loading the second cartridge the piece could not be fired until block was entirely opened (thus ejecting the unfired cartridge), and the gun reloaded. This was probably caused by operator failing to throw block fully back when ejecting the first empty shell.

Test discontinued.

No. 51.—Springfield Single Loader No. 1.

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 42 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun having no magazine, the entire 20 shots were fired as a single loader in 1 minute and 14 seconds; 20 hits.

(*b*) *As single loader for 2 minutes.*—Thirty-six shots were fired, with 34 hits.

(*c*) *As magazine arm for 2 minutes.*—Test omitted.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 20 shots fired as a single loader in 42 seconds.

(*b*) *As single loader for 1 minute.*—After 21 shots had been fired in 43 seconds the last shell was left in chamber, the extractor tearing through cartridge head.

Repeating the test, 24 shots were fired.

(*c*) *As magazine arm for 1 minute.*—Test omitted.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—The gun having no magazine, was fired as a single loader. Test (as usual) conducted in sets of 50, after each of which gun was cooled. In 10 cases, near latter part of these sets of 50, as gun had become heated, the extractor tore through head, leaving shell in chamber. The cam also was occasionally lifted with difficulty.

(*b*) *As single loader for 100 rounds.*—Extractor three times tore through cartridge head, leaving shell in chamber.

IV. DUST.

(*a*) *Magazine empty when exposed.*—All cartridges fired as single loader; gun worked well.

(*b*) *Magazine loaded when exposed.*—All cartridges fired as single loader; gun worked well.

V. DEFECTIVE CARTRIDGES.

No injury whatever to mechanism from the three forms of defectives; gun worked well.

VI. EXCESSIVE CHARGES.

Extractor tore through head after second shot and failed to remove shell; otherwise gun worked well.

VII. EASE OF MANIPULATION.

Satisfactory.

SUPPLEMENTARY TESTS.

I. DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—After last dusting firing pin slightly wedged, freed by taps from cartridge shell; on examination after test was completed point was found to be broken. Last 5 shells in this test not ejected; on subsequent examination ejector spring and spindle were found uninjured, but clogged with dust.

(*b*) *As a magazine arm.*—Omitted.

II. RUST.

Gun fairly well rusted. Breechblock opened freely, and all parts worked well except ejector, which was rusted to spindle and failed to operate.

No. 52.—Springfield Single Loader No. 2.

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder, 10 shots in 37 seconds.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The gun having no magazine, the entire 20 shots were fired as a single loader in 1 minute and 18 seconds; 15 hits; ejector failed to throw out 1 shell.

(*b*) *As single loader for 2 minutes.*—On first trial the ejector failed to throw out the third shell. Repeating the test, 35 shots were fired, with 31 hits.

(*c*) *As magazine arm for 2 minutes.*—Test omitted.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 20 shots were fired as a single loader in 62 seconds. A delay was occasioned by two failures to eject.

(*b*) *As single loader for 1 minute.*—Seventeen shots were fired and 1 cartridge introduced in chamber. There was 1 failure to eject, and the accumulation of fouling and unburnt powder in front of counterbore and at seat of cam twice compelled pressure on the thumb piece to close the latch.

(*c*) *As magazine arm for 1 minute.*—Test omitted.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—The gun, having no magazine, was fired as a single loader. As the fouling and unburnt powder accumulated in front of counterbore and at seat of cam, pressure on the thumb piece was necessary to close the latch. In the 500 shots this assistance had to be given 142 times. There was one failure to eject.

(*b*) *As single loader for 100 rounds.*—In 17 instances pressure from the thumb was required to seat the cam. The breechblock was opened with considerable difficulty, in five cases blows from a lead hammer being necessary.

IV. DUST.

(*a*) *Magazine empty when exposed.*—All cartridges fired as a single loader. The dust and fouling prevented the independent closing of the cam, assistance from the operator being required for 19 of the 20 shots. Block worked stiffly and was opened with difficulty.

(*b*) *Magazine loaded when exposed.*—There being no magazine, all cartridges were fired as a single loader; the cam was assisted nine times; block worked stiffly but more easily than in first portion of test.

V. DEFECTIVE CARTRIDGES.

No injury whatever to mechanism from the three forms of defectives. The escaping gas blowing out all previous accumulations of dust, fouling and unburnt powder, the mechanism was freed and worked well.

VI. EXCESSIVE CHARGES.

Bolt opened with great difficulty, use of a lead hammer being twice necessary. Three failures to eject.

VII. EASE OF MANIPULATION.

When not clogged by dust, fouling, or unburnt powder, was satisfactory.

SUPPLEMENTARY TESTS.

I. DEFECTIVE CARTRIDGES AND DUST.

(*a*) *As a single loader.*—After second dusting block worked stiffly, blows from hammer being once required to open. Three failures to eject.

(*b*) *As a magazine arm.*—Test omitted.

II. RUST.

Gun thoroughly rusted. Firing pin rusted in hole protruding from face of block required drift and blows from a hammer to free and drive back. For 18 of the 20 shots pressure on thumb piece required to seat the cam. Blows from hammer required after each shot to open the block.

ADDITIONAL TEST.

To determine the average rapidity of fire of this arm in the hands of instructed but not especially expert soldiers, three men of the ordnance

detachment at Springfield Armory, one of whom had served a previous enlistment in the Marine Corps, U. S. Navy, one in the Tenth United States Infantry, and one in the Second United States Cavalry, fired, loading from a cartridge belt, 20 shots with aim at an A target, at a range of 100 yards. The average time for the three men for the 20 shots was 2 minutes and 22 seconds.

In this trial the cam latch failed 8 times to close automatically, independent pressure on the thumb piece being necessary before the gun could be fired.

No. 53.—Springfield Single Loader No. 3.

SAFETY TEST.

The gun was operated by the recorder of the board and fired from the shoulder 10 shots in 41 seconds. Thumb piece four times not seated until assisted by direct pressure from operator.

REGULAR TESTS.

I. RAPIDITY WITH ACCURACY.

(*a*) *As single-loader and then as repeating arm for contents of magazine.*—The gun having no magazine the entire 20 shots were fired, as a single loader in 1 minute and 21 seconds; 17 hits. Considerable force required to open block and extract empty shell. In 16 instances thumb piece of cam-latch not seated until after direct pressure from operator.

(*b*) *As single loader for 2 minutes.*—Twenty-five shot swere fired, with 25 hits, and 1 cartridge introduced into chamber. Considerable force often required to lift block and extract empty shell. In 13 instances pressure was required to seat thumb piece.

(*c*) *As magazine arm for 2 minutes.*—Test not possible.

II. RAPIDITY AT WILL.

(*a*) *As single loader and then as repeating arm for contents of magazine.*—The 20 shots were fired as a single loader in 1 minute and 30 seconds, so much time being required in consequence of the failure of the automatic seating of the cam, a strong pressure from the operator being necessary upon the thumb piece in 14 instances.

(*b*) *As single loader for 1 minute.*—Nineteen shots were fired. Thumb piece assisted in seating 5 times.

(*c*) *As magazine arm for 1 minute.*—Test not possible.

III. ENDURANCE.

(*a*) *As a magazine arm for 500 rounds.*—The gun having no magazine was fired as a single loader. The accumulation of fouling noted in the tests of the Springfield Nos. 1 and 2 was also observed with this gun and interfered as in the former cases with the automatic seating of the cam, separate pressure on the thumb piece being necessary in 96 instances.

Considerable force required after every shot to lift cam-latch and also to extract the empty shell.

There were 2 failures to eject. After 425 shots had been fired there

were a number of miss-fires. After the four hundred and thirty-fifth shot had been fired the firing pin was removed and the point discovered to be broken. Pin then replaced by a new one; no more miss-fires occurred.

(*b*) *As single loader for 100 rounds.*—Considerable force required after every shot to lift cam-latch and to extract empty shell. Twelve failures to automatically seat thumb piece.

On completion of firing, the gun was examined and a very noticeable impression of the cam observed on the face of recess in breech screw.

To this may possibly be ascribed some of the difficulty in operating the mechanism after each discharge.

ADDITIONAL TEST.

After 10 preliminary shots (3 failures in the automatic seating of thumb piece), the gun was fired by the recorder, loading from the cartridge belt, at an A target, at range of 100 yards, 20 shots in 2 minutes and 6 seconds; 16 hits.

Time of firing was unduly prolonged by 9 failures in the automatic seating of thumb piece and the considerable force required to operate block after each discharge.

Further tests suspended.

PART IV.—*Tabulated synopsis of tests of guns.*

Table showing weight, capacity of magazine, and results of test of each magazine arm before the board.

Number on docket.	Name of gun.	Type of magazine.	Cartridges in magazine.	Weight, without bayonet.		Weight of ammunition.			Complete cartridge.		Muzzle velocity.	Caliber of gun.	Safety test.		Remarks.
				With magazine empty.	With magazine full.	Bullet.	Powder.	Complete cartridge.	Length.	Diameter under head.			Time.	Miss-fires.	
				Lbs. Ozs.	*Lbs. Ozs.*	*Grs.*	*Grs.*	*Grs.*	*Inches.*	*Inches*	*Ft. sec.*	*Inches.*	*Min.*		
1	Lee-Speed (England)	Detachable box; under receiver.	8	9 6	9 14.3	214	66	455	3.052	.458	1,832	.303	30	....	Charge, compressed black powder.
2	Krag-Jörgensen (Denmark).	Horizontal fixed box; under and to left of receiver.	5	9 8	9 13.1	235	76	490	2.988	.502	1,770	.315	45	....	Do.
3	Mannlicher (Austria)	Vertical fixed box; under receiver.	5	10 1.5	10 7	215	40	423	2.973	.492	2,115	.315	30	....	Charge, compressed smokeless powder.
4	Mauser, M. 1889 (Belgium).	Semi-detachable box; under receiver.	5	8 12.5	9 1.5	216	43	435	3.077	.471	2,178	.301	25	....	Charge, Belgian smokeless powder.
5	Infantry rifle, M. 1888 (Germany).	Vertical fixed box; under receiver.	5	8 8	8 12.8	226	38	417	3.244	.465	2,056	.311	35	....	Charge, Spandau smokeless powder.
6	Kropatschek (Portugal).	Tubular; under barrel	8	10 3.5	10 13.4	245	70	539	3.222	.544	1,760	.315	68	....	Charge, black powder.
7	Murata (Japan)	....do	8	9 0	9 8.5	238	36	468	2.905	.492	1,850	.315	30	....	Charge, Wetteren smokeless powder.
8	Schmidt (Switzerland)	Semi-detachable box; under receiver.	12	10 5	11 0.5	215	30	418	2.944	.494	1,924	.295	35	....	Charge, smokeless powder.
9	Mannlicher carbine (Austria).	Same as No. 3	5	7 4	7 9.5	245	36	449	2.973	.492	1,598	.315	28	....	Charge, Wetteren smokeless powder.
10	Mannlicher (Roumania).	Vertical fixed box; under receiver.	5	8 10	8 14.3	165	36	346	2.953	.447	2,260	.256	26	....	Charge, Troisdorf smokeless powder.
11	Russian. M.1891														Fired by the recorder.
12	Berthier No. 1	Vertical fixed box; under receiver.	4	8 11	8 15.5	230	36	419	3.090	.460	2,000	.300	35	4	Fired by Mr. L. V. Benét.
13	Mauser No. 2	Same as No. 4	5	8 13.5	9 2	216	36	428	3.077	.471	1,960	.301	28	....	Fired by the recorder.
14	Sporer	Tubular; in butt stock	5	9 9	9 13.8	230	34	417	3.090	.460	1,925	.300	35	8	Do.
15	Bruce No. 1	Vertical hinged box; under receiver.	5	9 11	9 15.8	230	34	417	3.090	.460	1,925	.300	35	....	Do.
16	Bruce No. 2	Same as No. 15	5	9 11	9 15.8	230	34	417	3.090	.460	1,925	.300	38	....	Do.
17	Krag-Jörgensen No. 2.	Same as No. 2	5	8 6	8 10.8	230	34	417	3.090	.460	1,925	.300	32	....	Do.
18	Krag-Jörgensen No. 3.	....do	5	8 6	8 10.8	230	34	417	3.090	.460	1,925	.300	32	....	Do.

19	Krag-Jörgensen No. 4.	Box similar to No. 2, but with horizontally hinged gate.	5	8	7	8	11.8	230	34	416	3.090	.465	1.925	.300	28	....	Do.
20	Bruce No. 3.....	Vertical hinged box; a variation of No. 15.	5	9	12	10	0.8	230	34	417	3.090	.460	1.925	.300	34	....	Do.
21	Berthier No. 2.....	Same as number 12.....	4	8	11	8	15.5	230	36	419	3.090	.460	2.000	.300	38	....	Only 8 shots fired; last shell not extracted.
22	Pitcher.....	Skeleton frame; under receiver.	5	9	0	9	8	230	36	419	3.090	.460	2,000	.300	.....	....	Fired with lanyard.
23	Berthier No. 3.....	Same as number 12.....	5	8	11	8	15.5	230	36	419	3.090	.460	2,000	.300	32	....	Fired by the recorder.
24	Mauser No. 3.....	Detachable box; under receiver.	5	8	13.5	9	2	230	36	419	3.090	.460	2,000	.300	43	....	Fired by Mr. Alfons Mauser.
25	Lee No. 1.....	.....do	10	8	4	8	8.13	230	36	419	3.090	.460	2,000	.303	36	....	Fired by Mr. J. P. Lee.
26	Lee No. 2.....	.....do	5	8	4	8	1.5	230	36	419	3.090	.460	2,000	.300	38	....	Do
27	Mauser No. 4	Box fixed; magazine mechanism detachable.	5	8	13	9	1.5	230	36	419	3.090	.460	2,000	.300	26	....	Fired by Mr. Alfons Mauser.
28	Krag-Jörgensen No. 5.	Same as No. 19.....	5	8	11.5	9	0	230	36	419	3.090	.460	2,000	.300	32	....	Fired by Mr. E. Jörgensen.
29	Krag-Jörgensen No. 6.	.....do	5	8	14	9	2.5	230	36	418	3.090	.465	2,000	.300	27	....	Do.
30	Ford.....	Fan-shaped magazine; under receiver.	5	11	0	11	4.5	230	36	419	3.090	.460	2,000	.300	.....	....	Fired by Mr. John Ford.
31	Hampden No. 1	Attachable packet, to left of and above receiver.	5	7	15.5	8	7	230	36	419	3.090	.460	2,000	.300	55	....	Fired by Mr. Allen Webster.
32	Durst No. 1.....	Cylindrical; under receiver.....	10	8	4	8	13	230	36	419	3.090	.460	2,000	.300	55	....	Fired by Mr. M. H. Durst.
33	Larsen.....	Fixed; under receiver	5	11	0	11	4.5	230	36	419	3.090	.460	2.000	.300	44	1	Fired by Mr. Ivert Larsen.
34	Miles.....	Tubular; under barrel.....	9	12	0	12	8	230	36	419	3.090	.460	2,000	.300	92	....	Fired by Mr. Don D. Miles.
35	Savage No. 1.....	Revolving cylinder; under receiver.	9	10	4	10	11.7	230	36	419	3.090	.460	2,000	.300	26	1	Fired by Mr. Arthur Savage.
36	Mullins.....	Fixed; under receiver	3	8	5	8	8	230	36	419	3.090	.460	2,000	.300	.....	....	Time not taken.
37	Chaffee-Reece.....	Tubular; in butt-stock.....	5	9	9	9	13.5	230	36	419	3.090	.460	2,000	.300	29	....	Fired by the recorder.
38	Blake No. 1	Revolving cartridge packet; under receiver.	7	9	10	10	3	230	36	419	3.090	.460	2,000	.300	40	....	Fired by Mr. John H. Blake.
39	Lee No. 3	Detachable box; underr eceiver.	10	8	3.5	8	12.5	230	36	419	3.090	.460	2,000	.300	37	....	Fired by Mr. J. P. Lee.
40	Hampden No. 2	Attachable packet to left and above receiver.	5	7	15.5	8	7	230	36	419	3.090	.460	2,000	.300	50	....	Fired by Mr. T. B. Wilson.
41	Russell-Livermore No. 1.	Magazine below receiver.....	5	9	0	9	4.5	216	39	430	3.052	.458	2,080	.303	33	....	Fired by Capt. A. H. Russell, U. S. Army.
42	Russell-Livermore No. 2.	Magazine on side of receiver ...	5	9	11	9	15.5	216	39	430	3.052	.458	2,080	.303	34	....	Do.
43	Savage No. 2.....	Same as No. 35	9	10	4	10	11.7	230	36	419	3.090	.460	2,000	.300	25	....	Fired by Mr. Arthur Savage.
44	Fogerty	Tubular; in butt-stock.....	6	11	9	11	14.5	230	36	419	3.090	.460	2,000	.300	73	....	Fired by Mr. George Fogerty.
45	Durst No. 2	Same as No. 32	10	8	4	8	13	230	36	419	3.090	.460	2,000	.300	46	....	Fired by Mr. M. H. Durst.
46	Mauser No. 5	Similar to No. 27	5	8	13.5	9	2	230	36	442	3.077	.471	2,000	.300	26	....	Fired by Mr. Alfons Mauser.
47	Blake No. 2.....	Same as No. 38	7	9	10	10	3	230	36	419	3.090	.460	2,000	.300	.....	....	Test omitted.
48	Rubin (Swiss)	Under receiver.....	6	9	6	9	12	217	69	450	3.087	.450	1,800	.295	.....	....	Do.
49	Schulhof, M. 1888.....	.....do	8	9	10	10	1	215	58	386	2.956	.450	1,875	.300	.....	....	Not tested.
50	Kelton.....	Single loader; attached magazine.	10	9	9	10	10	500	70	745	2.792	.503	1,315	.450	.....	....	Time not taken.
51	Springfield No. 1.....	Single loader.....	....	9	3	.....		230	36	419	3.090	.460	2,000	.300	42	....	Fired by the recorder
52	Springfield No. 2.....	.....do	....	9	3	.....		230	36	419	3.090	.460	2,000	.300	37	....	Do.
53	Springfield No. 3.....	.....do	....	9	3	.....		230	36	419	3.090	.460	2,000	.300	41	....	Do.

Table showing weight, capacity of magazine, and results of test of each magazine arm before the board—Continued.

REGULAR TESTS.

Number on docket.	Name of gun.	I. Rapidity with accuracy.														
		(a) For 20 shots.					(b) As single loader for 2 minutes.					(c) As magazine gun for 2 minutes.				
		Shots as single loader.	Shots from magazine.	Hits.	Time.	Remarks.	Shots.	Hits.	Miss-fires.	Remaining in chamber.	Remarks.	Shots.	Hits.	Miss-fires.	Remaining in magazine.	Remarks.
					"											
1	Lee-Speed	12	8	18	49	17" for shots in magazine	49	39				17	16		7	
2	Krag-Jörgensen	15	5	18	55	11" for shots in magazine	42	37				35	24		5	Second trial.
3	Mannlicher	15	5	18	54	12" to charge and fire magazine	38	34			Ninth trial, ammunition defective.	49	45		1	
4	Mauser, M. 1889	16	4	20	69	6" for shots in magazine	31	30			Sixth trial	36	34		4	Do.
5	German infantry rifle	15	5	20	91	14" to charge and fire magazine	28	26		1	Second trial	24	23		1	
6	Kropatschek	12	8	19	140	50" for shots in magazine; difficult to operate.	24	18			Much force required to operate.	16	16		5	Much force required to operate.
7	Murata	12	8	15	58	21" for shots from magazine	36	35				24	21		1	
8	Schmidt	8	12	16	56	28" for shots from magazine	31	25				37	32		8	One cartridge left in chamber.
9	Mannlicher carbine	15	5	16	59	13" to charge and fire magazine	38	35				40	27			Fourth trial worked stiffly.
10	Mannlicher (Roumania)	15	5	19	52	12" to charge and fire magazine	41	38				48	48		2	
11	Russian															
12	Berthier No. 1	16	4	16	59	11" for shots from magazine	38	26	10		Third trial					Test not completed in 8 trials.
13	Mauser No. 2	16	4	19	80	8" for shots from magazine	42	37				40	39			
14	Sporer	15				Gun withdrawn										
15	Bruce No. 1	15	5	19	51	12" for shots from magazine	38	36				34	31		1	Second trial.
16	Bruce No. 2	15	5	20	70	15" for shots from magazine	36	29				31	24		1	
17	Krag-Jörgensen No. 2	15	5	19	57	10" for shots from magazine	41	23			One shell not ejected	34	31		4	Do.
18	Krag-Jörgensen No. 3	15	5	18	55	12" for shots from magazine	42	35				40	39		5	
19	Krag-Jörgensen No. 4	15	5	17	54	10" for shots from magazine	39	38				37	35		3	
20	Bruce No. 3	15	5	16	62	14" for shots from magazine	37	28				23	16	1	4	
21	Berthier No. 2	16	4	11	60	Five miss-fires	37	28	9		Second trial					Test not completed in 7 trials.
22	Pitcher					Test omitted					Test omitted					Test omitted.
23	Berthier No. 3	16	4			Test not completed										
24	Mauser No. 3	15	5	17	49	9" for shots from magazine	40	34		1		40	37			One cartridge in chamber third trial.
25	Lee No. 1	10	10			Test not completed										
26	Lee No. 2	15	5	19	51	10" for shots from magazine	44	40	1			20	19		4	One cartridge in chamber.
27	Mauser No. 4	15	5	16	60	14" to charge and fire magazine	40	39				37	36		1	Do.

28	Krag-Jörgenson No. 5	15	5	16	54	10″ for shots from magazine	38	35	....	1		43	38	....	....	Do.
29	Krag-Jörgensen No. 6	15	5	16	54	9″ for shots from magazine	42	41	....	....		46	39	....	3	Do.
30	Ford	....	....	....	....		....	....	....	....		....	....	....	....	
31	Hampden	15	5	19	56	11″ for shots from magazine	41	35	....	....		45	39	....	4	One cartridge not fed down.
32	Durst No. 1	10	10	....	....	Test discontinued after fourth trial.	....	....	....	....		....	....	....	....	
33	Larsen	15	5	19	100	22″ for shots from magazine	25	25	....	....		20	15	....	5	Second trial.
34	Miles	2	....	....	300	Mechanism broken	....	....	....	....		....	....	....	....	
35	Savage No. 1	14	6	14	68	13″ for shots from magazine	36	31	1	....		24	24	....	2	
36	Mullins	17	3	18	112	17″ for shots from magazine	27	27	....	....		7	7	....	2	Failures to extract.
37	Chaffee-Reece	15	5	17	59	15″ for shots from magazine	44	38	....	....		20	19	....	....	
38	Blake No. 1	13	7	15	80	23″ for shots from magazine	28	27	....	1	Two failures to eject	15	14	....	....	Cartridge in chamber, third trial.
39	Lee No. 3	10	10	20	79	34″ for shots from magazine	43	37	....	....		45	41	....	5	
40	Hampden No. 2	15	5	20	69	15″ for shots from magazine	45	35	....	....		50	38	1	....	Sixth trial.
41	Russell-Livermore No. 1	15	5	16	52	Fifth trial—only 19 shots fired	35	32	....	1		35	31	4	....	Fifth trial.
42	Russell-Livermore No. 2	15	5	19	64	10″ for shots from magazine	37	30	....	1		31	25	....	3	Third trial—1 cartridge in chamber.
43	Savage No. 2	12	8	16	55	15″ for shots from magazine	34	24	....	....		35	23	....	....	1 cartridge left in chamber.
44	Fogerty	14	6	11	166	68″ for shots from magazine	....	....	....	....		....	....	....	....	
45	Durst No. 2	10	1	....	75	Only one shot fired from magazine	....	....	....	....		....	....	....	....	
46	Mauser No. 5	15	5	19	52	10″ for shots from magazine	46	44	....	....		47	47	....	3	
47	Blake No. 2	....	....	....	....	Test omitted, see Blake No. 1	....	....	....	....	Test omitted, see Blake No 1.	9	7	....	....	Time for 9 shots, 44 seconds.
48	Rubin (Swiss)	14	6	17	74	19″ for shots from magazine	....	....	....	....	Test omitted	27	27	....	....	
49	Schulhof, M. 1888	....	....	....	....		....	....	....	....		....	....	....	....	
50	Kelton	10	10	18	110	57″ for shots from quick loader	26	25	....	....		2	....	....	....	Only 2 shots fired.
51	Springfield No. 1	20	....	20	74		36	34	....	....		....	....	....	....	Test omitted.
52	Springfield No. 2	20	....	15	78		35	31	....	....		....	....	....	....	Do.
53	Springfield No. 3	20	....	17	81		25	25	....	....	13 failures of cam to seat	....	....	....	....	Do.

Table showing weight, capacity of magazine, and results of test of each magazine arm before the board—Continued.

REGULAR TESTS—Continued.

Number on docket.	Name of gun.	II. Rapidity at will.											
		(a) For 20 shots.				(b) As single loader for 1 minute.				(c) As magazine gun for 1 minute.			
		Shots as single loader.	Shots from magazine.	Time.	Remarks.	Shots.	Miss-fires.	Remaining in chamber.	Remarks.	Shots.	Miss-fires.	Remaining in magazine.	Remarks.
				"									
1	Lee-Speed	12	8	38	11" for shots from magazine	28	....	.....		11	....	5	
2	Krag-Jörgensen	15	5	37	7" for shots from magazine	28	....	.....	Slight delay to close magazine gate.	25	....	5	Second trial.
3	Mannlicher	15	5	40	9" to charge and fire magazine	....	....	.....	Omitted; lack of suitable ammunition.	....	....	.....	Omitted; lack of suitable ammunition.
4	Mauser, M. 1889	16	4	51	5" for shots from magazine	18	....	.....		21	1	.....	Third trial.
5	German infantry rifle	15	5	69	11" to charge and fire magazine	18	....	1		20	....	.....	Ammunition packet half introduced.
6	Kropatschek	12	8	120	42" for shots from magazine	17	....	.....	Bolt opened with difficulty	13	....	3	Bolt opened and closed with difficulty.
7	Murata	12	8	38	13" for shots from magazine	25	....	1		16	....	.....	
8	Schmidt	8	12	38	18" for shots from magazine	18	....	.....		25	....	11	Second trial.
9	Mannlicher carbine	15	5	48	11" to charge and fire magazine	25	....	.....		37	....	3	
10	Mannlicher (Roumania)	15	5	40	6" to charge and fire magazine	23	....	.....		40	....	.....	
11	Russian	.....	.....	.....		....	....	.....		....	....	.....	
12	Berthier No. 1	.....	.....	.....		....	....	.....		....	....	.....	
13	Mauser No. 2	16	4	62	6" for shots from magazine	25	....	.....		30	....	.....	
14	Sporer	.....	.....	.....		....	....	.....		....	....	.....	
15	Bruce No. 1	15	5	35	6" for shots from magazine	25	....	1		20	....	5	
16	Bruce No. 2	15	5	52	12" for shots from magazine	27	....	.....		24	....	.....	
17	Krag-Jörgensen No. 2	15	5	36	7" for shots from magazine	29	....	.....	Second trial	26	....	.....	Fifth trial; two failures to eject.
18	Krag-Jörgensen No. 3	15	5	34	6" for shots from magazine	26	....	.....		29	....	4	One additional cartridge in chamber.
19	Krag-Jörgensen No. 4	15	5	38	7" for shots from magazine	28	....	1		35	....	.....	
20	Bruce No. 3	15	5	50	15" for shots from magazine	27	....	.....		14	....	.....	One cartridge dropped in loading.
21	Berthier No. 2	.....	.....	.....		....	....	.....		....	....	.....	
22	Pitcher	.....	.....	.....	Test omitted	....	....	.....	Test omitted	....	....	.....	Test omitted.
23	Berthier No. 3	.....	.....	.....		....	....	.....		....	....	.....	
24	Mauser No. 3	15	5	40	8" for shots from magazine	30	....	.....		15	....	.....	Cartridges stripped from clip with difficulty.
25	Lee No. 1	.....	.....	.....		....	....	.....		....	....	.....	

26	Lee No. 2	15	5	34	7″ for shots from magazine	25	....	1		14	....	.....	One cartridge in chamber.
27	Mauser No. 4	15	5	41	10″ to charge and fire magazine	27	....	.....		28	....	1	Do.
28	Krag-Jörgensen No. 5	15	5	39	7″ for shots from magazine	29	1	.....	Third trial	35	....	1	
29	Krag-Jörgensen No. 6	15	5	37	do	27	....	.....	1 other cartridge not properly introduced.	37	1	1	
30	Ford	.....	.....	.....	7″ for shots from magazine	26	....	.....		....	....	.....	Locking lug broke.
31	Hampden	15	5	36									
32	Durst No. 1	.....	.....	.....									
33	Larsen	15	5	80	20″ for shots from magazine	20	....	1		10	....	5	
34	Miles	.....	.....	.....		....	....	.....		....	....	.....	
35	Savage No. 1	14	6	43	7″ for shots from magazine	3	....	.....	Breechblock broken	....	....	.....	
36	Mullins	17	3	105	27″ for shots from magazine	....	....	.....		....	....	.....	
37	Chaffee-Reece	15	5	44	8″ for shots from magazine	27	....	.....		9	....	5	Magazine once charged with 4 cartridges.
38	Blake No. 1	13	6	60	Only 6 shots in 16″ fired from magazine.	18	....	1		6	1	.....	
39	Lee No. 3	10	10	30	11″ for shots from magazine	24	....	.....		39	....	10	
40	Hampden No. 2	15	5	34	5″ for shots from magazine	27	2	.....		30	....	5	
41	Russell-Livermore No. 1	15	4	44	Only 4 shots in 12″ from magazine.	25	....	.....		18	1	.....	Fifth trial.
42	Russell-Livermore No. 2	15	5	50	15″ for shots from magazine	18	....	1		29	....	1	Sixth trial.
43	Savage No. 2	12	8	61	21″ for shots from magazine	26	1	1		23	....	.....	
44	Fogerty	.....	.....	.....		....	....	.....		....	....	.....	
45	Durst No. 2	.....	.....	.....		....	....	.....		....	....	.....	
46	Mauser No. 5	15	5	42	9″ for shots from magazine	27	....	.....		33	....	2	
47	Blake No. 2	.....	.....	.....		....	....	.....		....	....	.....	
48	Rubin (Swiss)	.....	.....	.....		....	....	.....		....	....	.....	
49	Schulhof, M. 1888	.....	.....	.....		....	....	.....		....	....	.....	
50	Kelton	.....	.....	.....		....	....	.....		....	....	.....	
51	Springfield No. 1	20	.....	42		24	....	.....	Second trial	....	....	.....	Test omitted.
52	Springfield No. 2	20	.....	62	Delay caused by 2 failures to eject.	17	....	.....	Failure to eject, and fouling caused delay.	..	....	.....	Do.
53	Springfield No. 3	20	.....	90	14 failures in seating cam	19	....	.....	5 failures in seating cam	....	....	.....	Do.

Table showing weight, capacity of magazine, and results of test of each magazine arm before the board—Continued.

REGULAR TESTS—Continued.

Number on docket.	Name of gun.	III. Endurance.					
		(*a*) As magazine gun.			(*b*) As single loader.		
		Shots.	Miss-fires.	Remarks.	Shots.	Miss-fires.	Remarks.
1	Lee-Speed	500	.....	Magazine spring broke on 188th round. Carrier clip broke on 490th round.	100	.....	Bolt opened stiffly; mallet required no test.
2	Krag-Jörgensen	500	.....	Ejector spring broke on 5th round	100	.....	Mechanism worked easily.
3	Mannlicher	100	9	Nine failures to extract. Miss-fires occasioned by defective ammunition.	.....	.....	
4	Mauser, M. 1889	500	2	Seventeen failures to extract	100	3	Four failures to extract.
5	German infantry rifle	500	.....	Much force frequently required to free cartridges from loading packet.	100	.....	Test conducted with magazine empty.
6	Kropatschek	500	.....	Blows from hammer frequently required to operate bolt	100	.....	Blows from hammer frequently required to operate bolt.
7	Murata	500	11	Failures to eject, 4; to extract, 2; to properly feed from magazine, 19.	100	.....	
8	Schmidt	500	.....	Forty-nine failures to extract	100	.....	Five failures to extract.
9	Mannlicher carbine	100	.....	Not sufficient ammunition to complete test	.....	.....	Test omitted; lack of ammunition.
10	Mannlicher (Roumania)	500	.....	Worked well and easily	100	.....	Worked well and easily.
11	Russian	.....	.....	.....	.....	.....	
12	Berthier No. 1	.....	.....	.....	.....	.....	
13	Mauser No. 2	500	.....	Forward guard-plate screw worked loose. Magazine spring failed to properly feed.	100	.....	
14	Sporer	.....	.....	.....	.....	.....	
15	Bruce No. 1	500	.....	Bolt worked stiffly	100	.....	Blows from hammer frequently required to open bolt.
16	Bruce No. 2	500	.....	One cartridge not fed from magazine. Bolt worked stiffly.	100	.....	Magazine catch entirely opened 3 times and partly frequently.
17	Krag-Jörgensen No. 2	.....	.....	.....	.....	.....	
18	Krag-Jörgensen No. 3	500	.....	Worked well and easily	100	.....	Worked well and easily.
19	Krag-Jörgensen No. 4	500	.....	Increased force occasionally required to push cartridge from magazine to chamber.	100	.....	Do.
20	Bruce No. 3	500	.....	Magazine spring not fully retracted. Blows of hammer required.	100	.....	Worked well.
21	Berthier No. 2	.....	.....	.....	.....	.....	
22	Pitcher	.....	.....	Test omitted	28	.....	Gun generally disabled.
23	Berthier No. 3	.....	.....	.....	.....	.....	
24	Mauser No. 3	500	.....	Worked well	100	.....	Worked well.
25	Lee No. 1	.....	.....	.....	.....	.....	
26	Lee No. 2	500	28	Worked well	100	12	Worked well.
27	Mauser No. 4	500	.....	Difficulty experienced in stripping cartridges from clip	100	.....	Do.
28	Krag-Jörgensen No. 5	500	.....	Worked well and easily	100	.....	Worked well and easily.
29	Krag-Jörgensen No. 6	500	.....	....do	100	.....	Do.

30	Ford	.....	.....	.....	.....	.....	
31	Hampden	.....	.....	.....	.....	.....	
32	Durst	.....	.....	Very great difficulty experienced in operating mechanism.	100	.....	Mechanism worked with much difficulty.
33	Larsen	500	.....	.....	.....	.....	
34	Miles	.....	.....	.....	.....	.....	
35	Savage No. 1	.....	.....	.....	.....	.....	
36	Mullins	.....	.....	*Overhang of cocking piece broken on 125th shot*	.....	.....	
37	Chaffee-Reece	125	.....	.....	.....	.....	
38	Blake No. 1	.....	.....	.....	100	.....	Mechanism worked well.
39	Lee No. 3	500	.....	Several miss-fires; 2 failures to extract	100	.....	Several miss-fires; otherwise mechanism worked well.
40	Hampden No. 2	500	.....	Mechanism worked well	100	.....	Mechanism worked fairly well.
41	Russell-Livermore No. 1	500	5	Test conducted with only 4 cartridges in magazine	100	.....	Worked well.
42	Russell-Livermore No. 2	500	.....	Mechanism worked well	100	.....	Worked stiffly.
43	Savage No. 2	500	.....	Worked stiffly	100	.....	
44	Fogerty	.....	.....	.....	.....	.....	
45	Durst No. 2	.....	.....	.....	.....	.....	
46	Mauser No. 5	500	.....	Worked well and easily	100	.....	Worked well and easily.
47	Blake No. 2	.....	.....	.....	.....	.....	
48	Rubin (Swiss)	.....	.....	.....	.....	.....	
49	Schulhof, M. 1888	.....	.....	.....	.....	.....	
50	Kelton	.....	.....	.....	.....	.....	
51	Springfield No. 1	500	.....	Fired as single loader; extractor 10 times tore through cartridge head.	100	.....	Three failures to extract; extractor tore through head.
52	Springfield No. 2	500	.....	Fired as single loader; latch failed 142 times to close without assistance.	100	.....	Seventeen failures to close latch; hammer required 5 times to open.
53	Springfield No. 3	500	.....	Fired as single loader; latch failed 96 times to close without assistance.	100	.....	Twelve failures to seat cam; much force required to operate.

Table showing weight, capacity of magazine, and results of test of each magazine arm before the board—Continued.

REGULAR TESTS—Continued.

Number on docket.	Name of gun.	IV. Dust.					
		(*a*) Magazine empty when exposed.			(*b*) Magazine loaded when exposed.		
		Shots.	Miss-fires.	Remarks.	Shots.	Miss-fires.	Remarks.
1	Lee-Speed	20	.....	Bolt dry; worked very stiffly	20	.....	Mallet required to open bolt; carrier and spring failed to work.
2	Krag-Jörgensen	20	.....	Worked freely	20	.....	Bolt opened a little stiffly, but worked well.
3	Mannlicher	.....	.....		.....	.....	
4	Mauser, M. 1889	20	.....	Mechanism completely clogged; dismounted and cleaned	20	.....	Bolt worked stiffly.
5	German infantry rifle	20	.....	Single-loading fire held with magazine empty	20	.....	Single-loading fire held with magazine empty.
6	Kropatschek	.....	.....	Breech and magazine mechanism too much clogged to fire	.....	.....	
7	Murata	20	.....	Mechanism worked with great difficulty	20	.....	Last cartridge from magazine not fed into receiver.
8	Schmidt	20	.....	Worked stiffly	20	.....	Worked stiffly.
9	Mannlicher carbine	20	.....	Difficult to entirely close bolt; worked stiffly	20	.....	Worked very stiffly; difficult to entirely close bolt.
10	Mannlicher (Roumania)	20	.....	Mechanism at first worked stiffly	20	.....	At first required a mallet to operate mechanism.
11	Russian	.....	.....		.....	.....	
12	Berthier No. 1	.....	.....		.....	.....	
13	Mauser No. 2	20	.....		20	.....	First three shells not ejected.
14	Sporer	.....	.....		.....	.....	
15	Bruce No. 1	20	.....	Mechanism badly clogged; worked with difficulty	20	.....	Mechanism badly clogged; worked with difficulty.
16	Bruce No. 2	20	.....	Worked stiffly, blows of hammer required to open bolt after last shot.	20	.....	Mechanism worked stiffly.
17	Krag-Jörgensen No. 2	.....	.....		.....	.....	
18	Krag-Jörgensen No. 3	20	.....	Worked freely	20	.....	Worked freely.
19	Krag-Jörgensen No. 4	20	.....	....do	20	.....	Do.
20	Bruce No. 3	20	.....	Hammer required to open magazine after dusting	20	.....	Magazine spring held down by operator when loading.
21	Berthier No. 2	.....	.....		.....	.....	
22	Pitcher	.....	.....		.....	.....	
23	Berthier No. 3	.....	.....		.....	.....	
24	Mauser No. 3	20	.....	Worked well	20	.....	Magazine turned on with difficulty.
25	Lee No. 1	.....	.....		.....	.....	
26	Lee No. 2	20	3	Second and third cartridges from magazine not fed up	20	.....	Second cartridge not fed up; magazine spring clogged.
27	Mauser No. 4	20	.....	Worked well	20	.....	Worked well.
28	Krag-Jörgensen No. 5	20	.....	Worked freely	20	.....	Worked freely.
29	Krag-Jörgensen No. 6	20	.....	....do	20	.....	Do.
30	Ford	.....	.....		.....	.....	
31	Hampden	.....	.....		.....	.....	

32	Durst No. 1			Worked with extreme difficulty	20	Worked with extreme difficulty.
33	Larson	20				
34	Miles					
35	Savage No. 1					
36	Mullins					
37	Chaffee-Reece					
38	Blake No. 1			Worked well	20	Worked well.
39	Lee No. 3	20		do	20	Do.
40	Hampden No. 2	20		do	20	Worked with difficulty.
41	Russell-Livermore No. 1	20		Worked stiffly	20	Magazine lever did not work well.
42	Russell-Livermore No. 2	20		Worked fairly well	20	Could not be operated until dismounted and cleaned.
43	Savage No. 2	20		Mechanism worked very stiffly	20	
44	Fogerty					
45	Durst No. 2					
46	Mauser No. 5	20		Worked stiffly; second cartridge not fed from magazine	20	Third cartridge from magazine not fed up.
47	Blake No. 2					
48	Rubin (Swiss)					
49	Schulhof, M. 1888					
50	Kelton					
51	Springfield No. 1	20		Fired as single loader; gun worked well	20	Fired as single loader; gun worked well.
52	Springfield No. 2	20		Fired as single loader; assistance required 19 times to close cam.	20	Fired as single loader; assistance given cam latch 9 times.
53	Springfield No. 3					

Table showing weight, capacity of magazine, and results of test of each magazine arm before the board—Continued.

REGULAR TESTS—Continued.

Number on docket.	Name of gun.	V. Defective cartridges.			VI. Excessive charges.		
		Shots.	Miss-fires.	Remarks.	Shots.	Miss-fires.	Remarks.
1	Lee-Speed	3	.....	Extractor spring broken; carrier forced to bottom of magazine.	5	.....	Bolt opened with difficulty; bolthead screw loose.
2	Krag-Jörgensen	3	.....	No injury whatever	5	.....	Bolt opened freely; worked well.
3	Mannlicher	.....	.....	.....	.....	.....	
4	Mauser, M. 1889	2	.....	Extractor bent; bolt could not be opened	.....	.....	
5	German infantry rifle	2	.....	Ejector and firing pin broken and blown to rear	.....	.....	
6	Kropatschek	.....	.....	.....	.....	.....	
7	Murata	3	.....	No injury whatever	5	.....	Bolt moved with difficulty; ejector weak.
8	Schmidt	1	.....	Magazine box broken and blown from gun	.....	.....	Test omitted.
9	Mannlicher carbine	3	.....	No injury whatever	5	.....	Bolt opened freely; worked well.
10	Mannlicher (Roumania)	3	.....	....do	.....	.....	No proper ammunition available.
11	Russian	.....	.....	.....	.....	.....	
12	Berthier No. 1	.....	.....	.....	.....	.....	
13	Mauser No. 2	1	.....	Ejector and bolt stop broken; extractor bent	.....	.....	
14	Sporer	.....	.....	.....	.....	.....	
15	Bruce No. 1	1	.....	Extractor broken	.....	.....	
16	Bruce No. 2	3	.....	No injury whatever	5	.....	Worked well.
17	Krag-Jörgensen No. 2	.....	.....	.....	.....	.....	
18	Krag-Jörgensen No. 3	3	.....	No injury whatever	5	.....	Bolt opened freely; worked well.
19	Krag-Jörgensen No. 4	1	.....	Dust cover and casing broken; bolt could not be opened	.....	.....	
20	Bruce No. 3	.....	.....	.....	.....	.....	
21	Berthier No. 2	.....	.....	.....	.....	.....	
22	Pitcher	.....	.....	.....	.....	.....	
23	Berthier No. 3	.....	.....	.....	.....	.....	
24	Mauser No. 3	3	.....	Ejector slightly sprung	5	.....	Bolt opened freely; worked well.
25	Lee No. 1	.....	.....	.....	.....	.....	
26	Lee No. 2	.....	.....	.....	.....	.....	
27	Mauser No. 4	1	.....	Extractor collar broken	.....	.....	
28	Krag-Jörgensen No. 5	3	.....	No injury whatever; mechanism worked well	5	.....	Bolt opened freely; worked well.
29	Krag-Jörgensen No. 6	3	.....	....do	5	.....	First cartridge shell not extracted, otherwise worked well.
30	Ford	.....	.....	.....	.....	.....	
31	Hampden	.....	.....	.....	.....	.....	
32	Durst	.....	.....	.....	.....	.....	
33	Larsen	1	.....	Extractor buckeled; magazine box broken	.....	.....	
34	Miles	.....	.....	.....	.....	.....	
35	Savage No. 1	.....	.....	.....	.....	.....	
36	Mullins	.....	.....	.....	.....	.....	
37	Chaffee-Reece	.....	.....	.....	.....	.....	
38	Blake No. 1	.....	.....	.....	.....	.....	

39	Lee No. 3	3	.....	No injury whatever; gun worked well	5	.....	Mechanism worked well.
40	Hampden No. 2	3	.....	No injury whatever; mechanism worked well	5	.....	Mechanism worked freely and well.
41	Russell-Livermore No. 1	3	.....	No injury to mechanism	.....	.....	Test omitted.
42	Russell-Livermore No. 2	1	.....	Extractor spring broken; walls of magazine bent and spread.	.....	.....	
				Extractor slightly sprung	5	.....	Empty shells not extracted; gun worked stiffly.
43	Savage No. 2	3	.....	.....	.....	.....	
44	Fogerty	.....	.....	.....	.....	.....	
45	Durst No. 2	.....	.....	.....	.....	.....	
46	Mauser No. 5	3	.....	No injury whatever; mechanism worked well	.....	.....	Test omitted.
47	Blake No. 2	.....	.....	.....	.....	.....	
48	Rubin (Swiss)	.....	.....	.....	.....	.....	
49	Schulhof, M. 1888	.....	.....	.....	.....	.....	
50	Kelton	.....	.....	.....	.....	.....	
51	Springfield No. 1	3	.....	No injury whatever; gun worked well	5	.....	One failure to extract.
52	Springfield No. 2	3	.....	....do	5	.....	Hammer required twice to open bolt; three failures to eject.
53	Springfield No. 3	.....	.....	.....	.....	.....	

Table showing weight, capacity of magazine, and results of test of each magazine arm before the board—Continued.

SUPPLEMENTARY TESTS.

Number on docket.	Name of gun.	Defective cartridges and dust.		Rust.
		(*a*) As single loader.	(*b*) As magazine arm.	
		Remarks.	Remarks.	Remarks.
2	Krag-Jörgensen (Denmark) ..	Worked well and easily	Mechanism worked well.....	Mechanism worked well, but rather stiffly.
9	Mannlicher carbine (Austria).	Mallet required to manipulate bolt	.....	
10	Mannlicher (Roumania)	Mallet occasionally required to manipulate bolt; worked very stiffly.	Mallet occasionally required; worked stiffly	Mechanism could not be operated.
16	Bruce No. 2.....	Mechanism dismounted and cleaned before it could be operated.	Screw of guide in magazine fell out and lost; cartridges not fed up.	
18	Krag-Jörgensen No. 3	Failed to eject; otherwise worked well.....	Failed to eject; otherwise worked well and smoothly.	Mechanism worked well.
28	Krag-Jörgensen No. 5	Worked well.....	Worked well.....	Mechanism could be worked, but stiffly.
29	Krag-Jörgensen No. 6	.....do	Worked rather stiffly.....	Mechanism worked well, but stiffly.
39	Lee No. 3.....	Extractor blown off; replaced; then worked well.	.....do	Mallet required to operate bolt.
40	Hampden No. 2.....	Two failures to extract; otherwise worked well.	Two failures to extract; otherwise worked well.	Mallet required to operate bolt; firing pin clogged; gun could not be fired.
41	Russell-Livermore No. 1.....	Extractor and magazine spring broken; gun disabled.	.....	
46	Mauser No. 5.....	Ejector failed to work	Ejector failed to work; cartridges not fed quickly from magazine.	Worked well.
51	Springfield No. 1	Ejector failed to operate	Test omitted	Ejector failed to operate; spring rusted to spindle.
52	Springfield No. 2	Worked stiffly; mallet required to open block.	.....do	Mallet required after each shot to open block.

Table showing weight, capacity of magazine, and results of test of each magazine arm before the board—Continued.

ADDITIONAL TESTS.

[Twenty shots, with aim, at A target—range 100 yards.]

Number on docket.	Name of gun.	Average of the results of firing by three enlisted men; loading from cartridge belt.				Average of the total time for firing twenty shots.	Remarks.
		Single-loading fire.		Magazine fire.			
		Number of shots.	Time of firing.	Number of shots.	Time of firing.		
			′ ″		′ ″	′ ″	
10	Mannlicher (Roumania)	15	1 42	5	23	2 5	Men unfamiliar with action of bolt guns and manipulated them all awkwardly and slowly.
28	Krag-Jörgensen No. 5.....	15	1 24	5	26	1 50	
29	Krag-Jörgensen No. 6.....	15	1 28	5	22	1 50	
39	Lee No. 3	10	1 5	10	1 2	2 24	17″ required after single-loading fire to turn on the magazine; cut-off working hard.
40	Hampden No. 2	15	1 35	5	26	2 1	
46	Mauser No. 5.....	15	1 29	5	23	1 52	
52	Springfield No. 2	20	2 22	.....	.....	2 22	Men familiar with Springfield mechanism and manipulated it smoothly. Cam not always closing automatically caused some delay.

NO. 1.

PLATE I.

LEE-SPEED

(ENGLAND.)

Fig. 3.

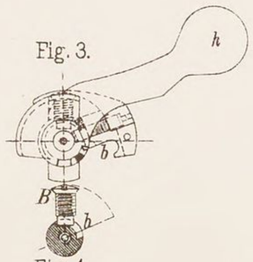


Fig. 4.

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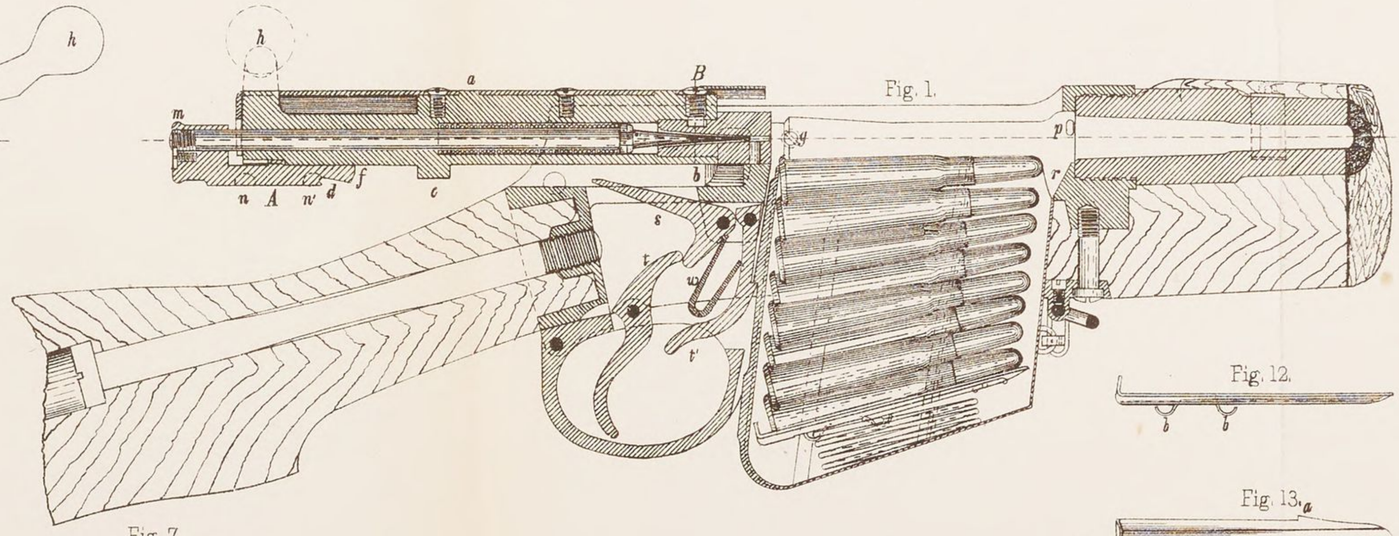

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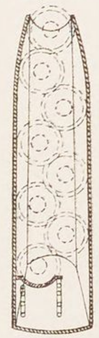
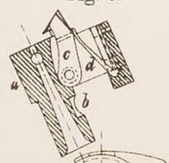


Fig. 12.

Fig. 13.

Fig. 5.



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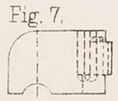

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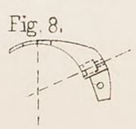

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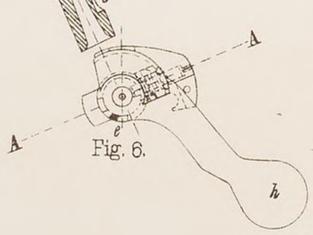

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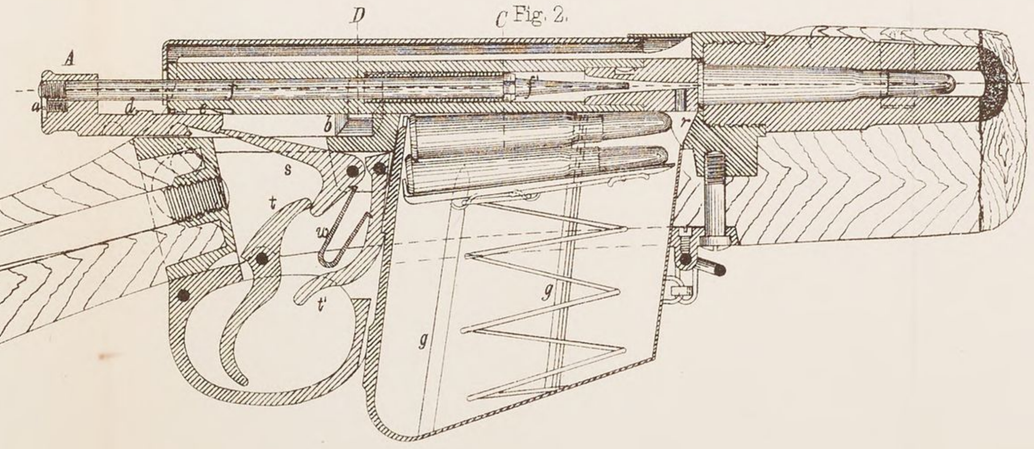

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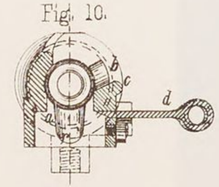


Fig. 11.

Appendix 9, 1892.

Ord 52 2

No. 1.

LEE-SPEED

(ENGLAND)

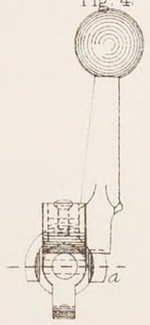
PLATE II.

NO. 2.

KRAG-JÖRGENSEN.

(DENMARK.)

Fig. 4.



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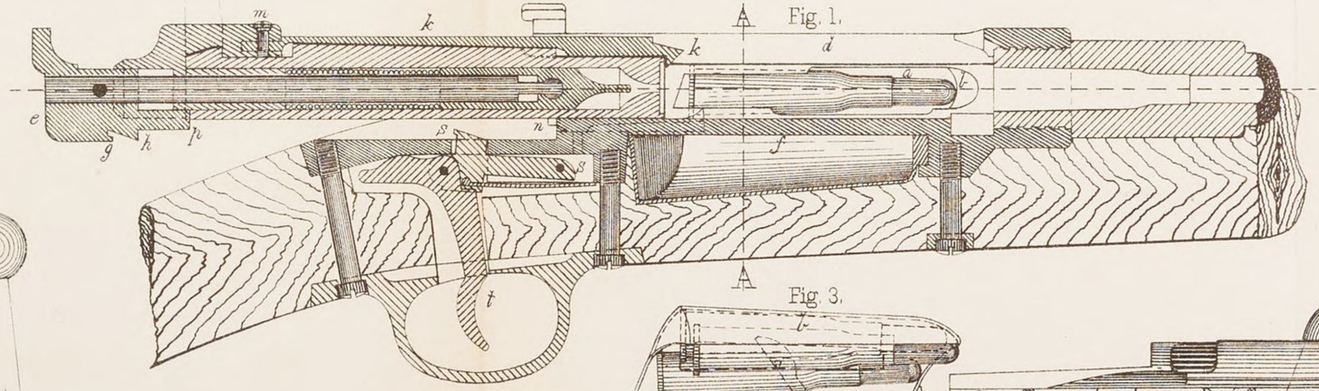

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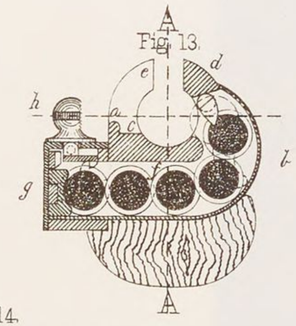

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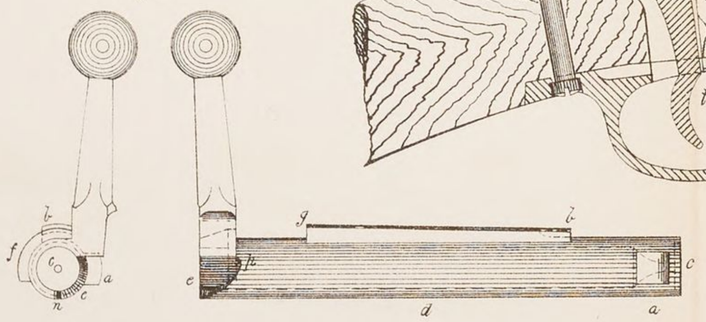

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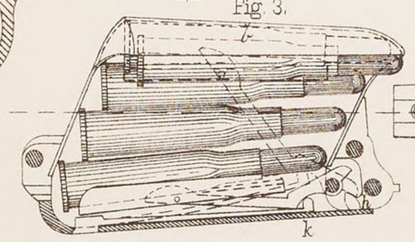

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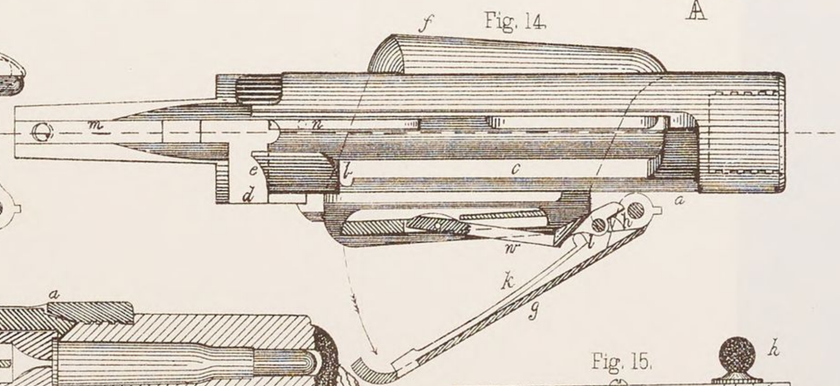

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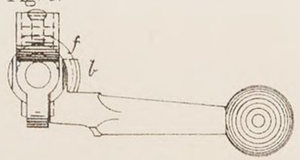

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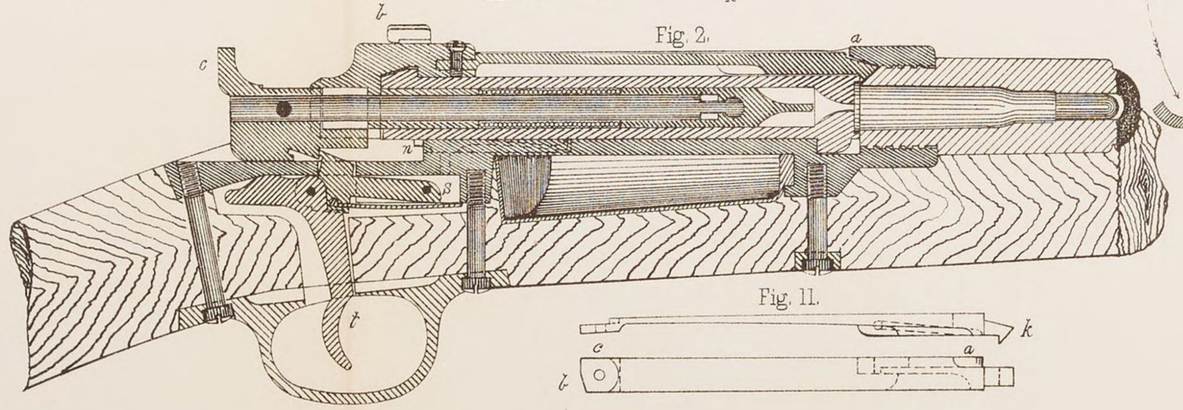

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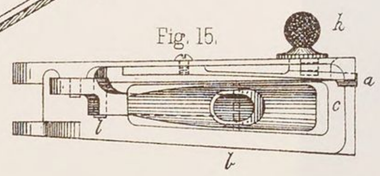

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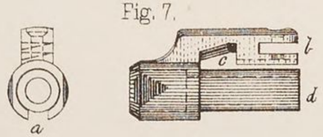

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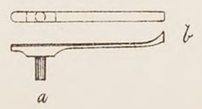

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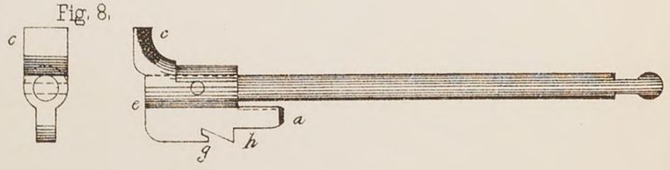

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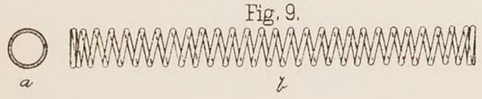

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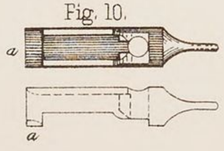


PLATE II.

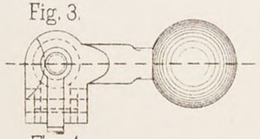
NO. 3.

PLATE III.

MANNLICHER.

(AUSTRIA)

Fig. 3.



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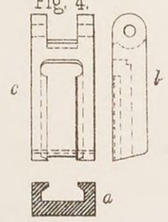

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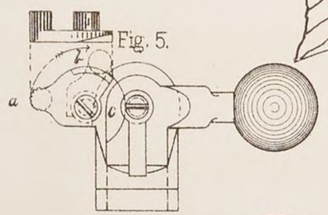

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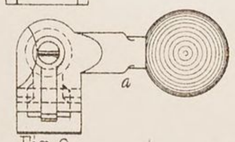

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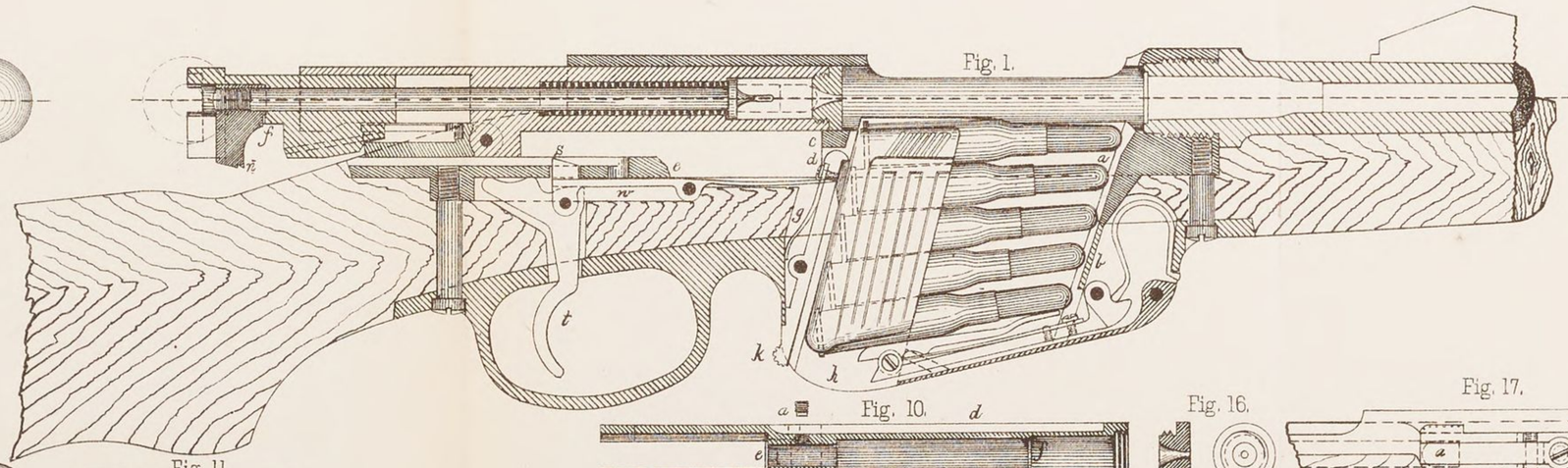
Fig. 7.

B

Fig. 8.

B

Fig. 1.



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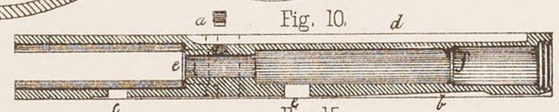

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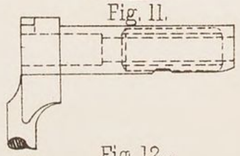
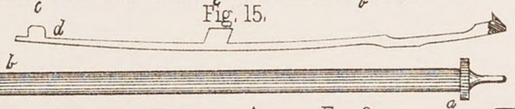


Fig. 12.

Fig. 13.

Fig. 14.

Fig. 15.



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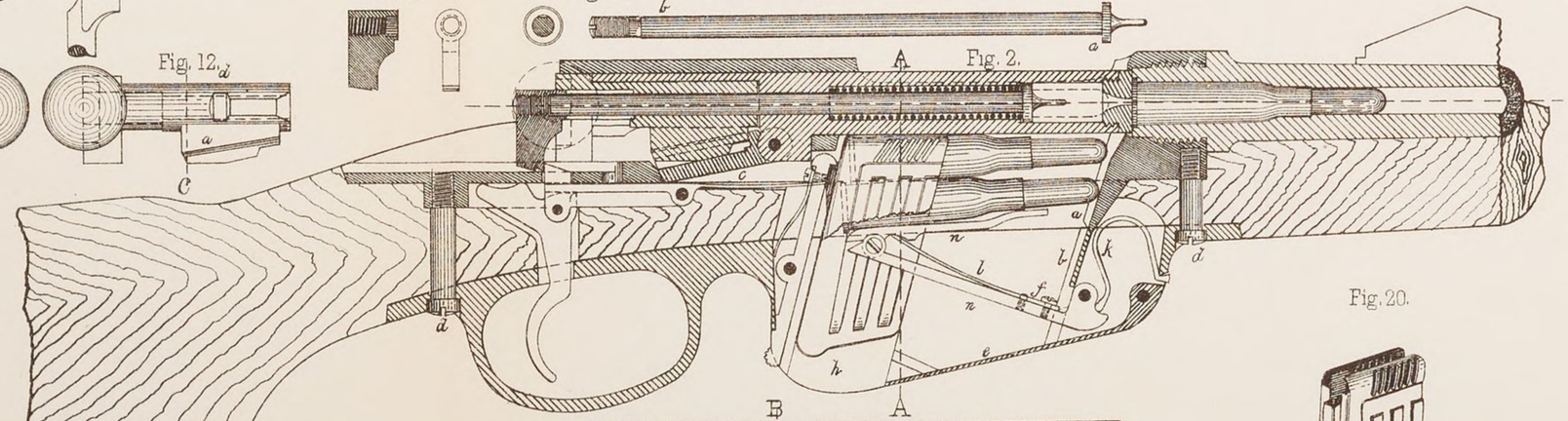

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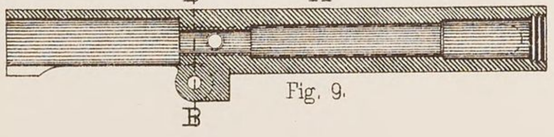


Fig. 9.

Fig. 16.

Fig. 17.

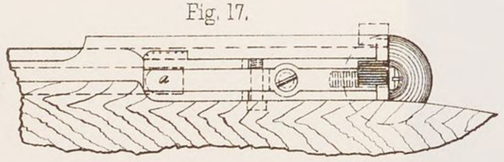


Fig. 18.

Fig. 19.

A A.

Fig. 20.

No. 3.

MANLICHER.

(AUSTRIA.)

NO. 4.

MAUSER.

(BELGIUM.)

PLATE IV.

Fig. 4.

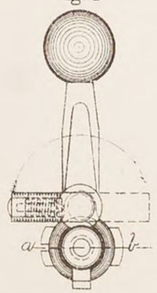
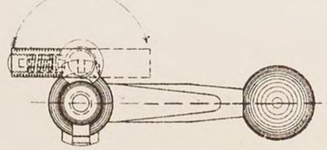


Fig. 5.

Fig. 6.



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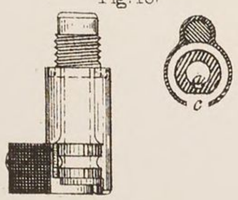

Fig. 7.

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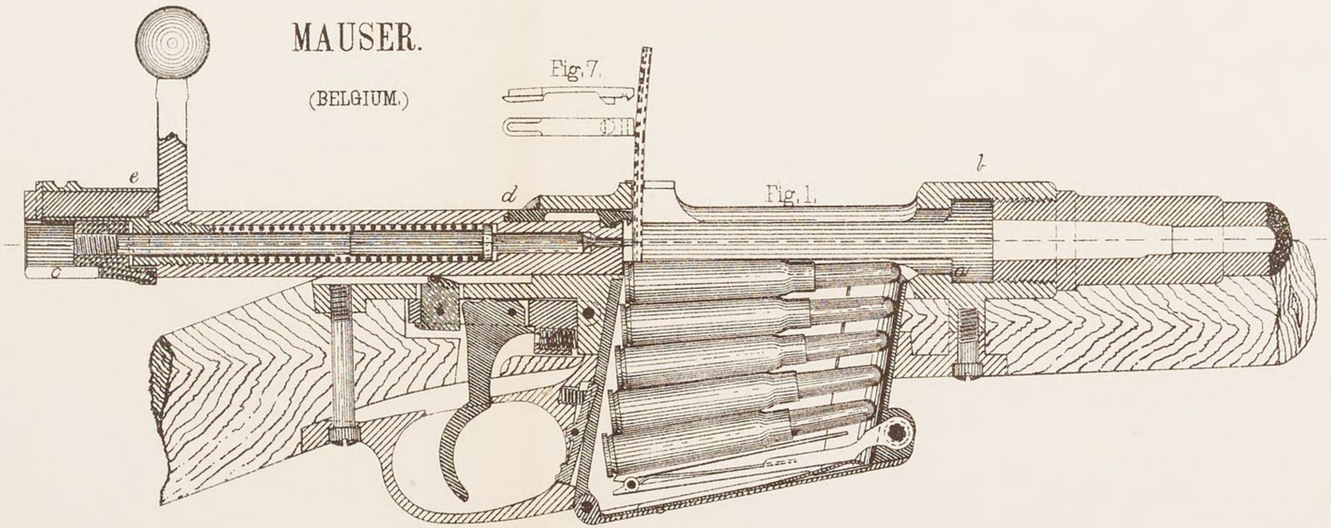

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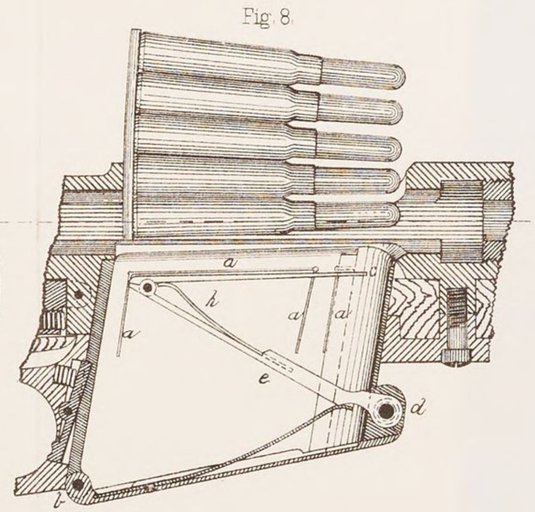

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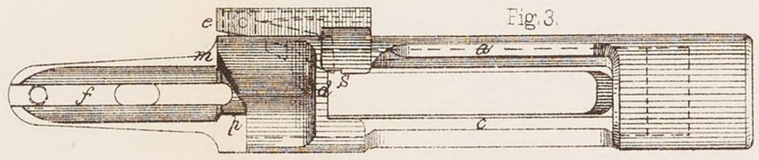

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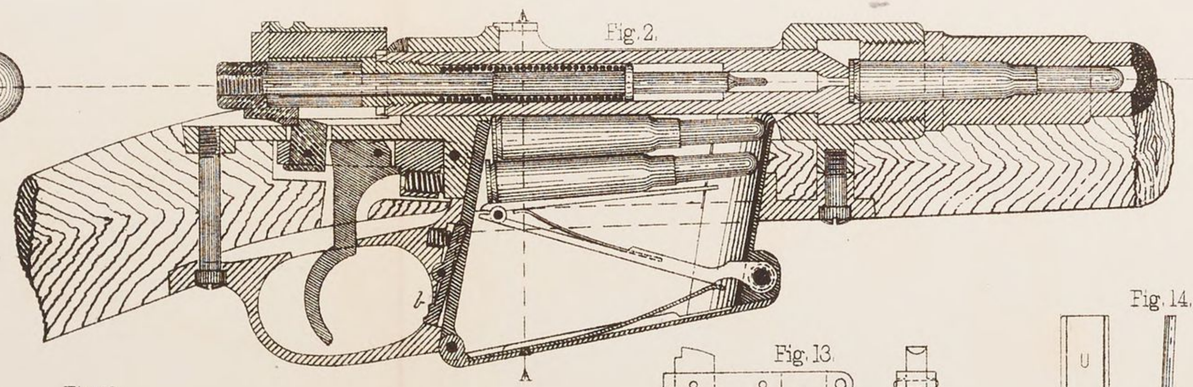

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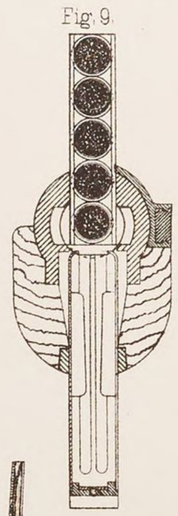

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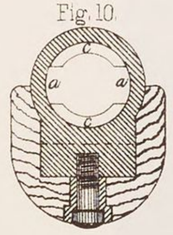

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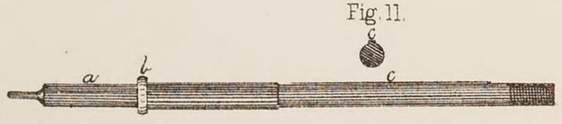

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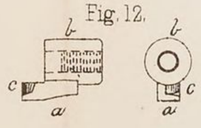

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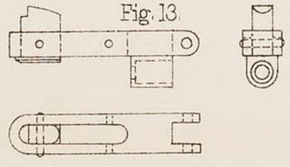

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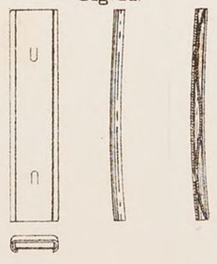

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NO. 5.

PLATE V.

INFANTRY RIFLE, MOD. '88.

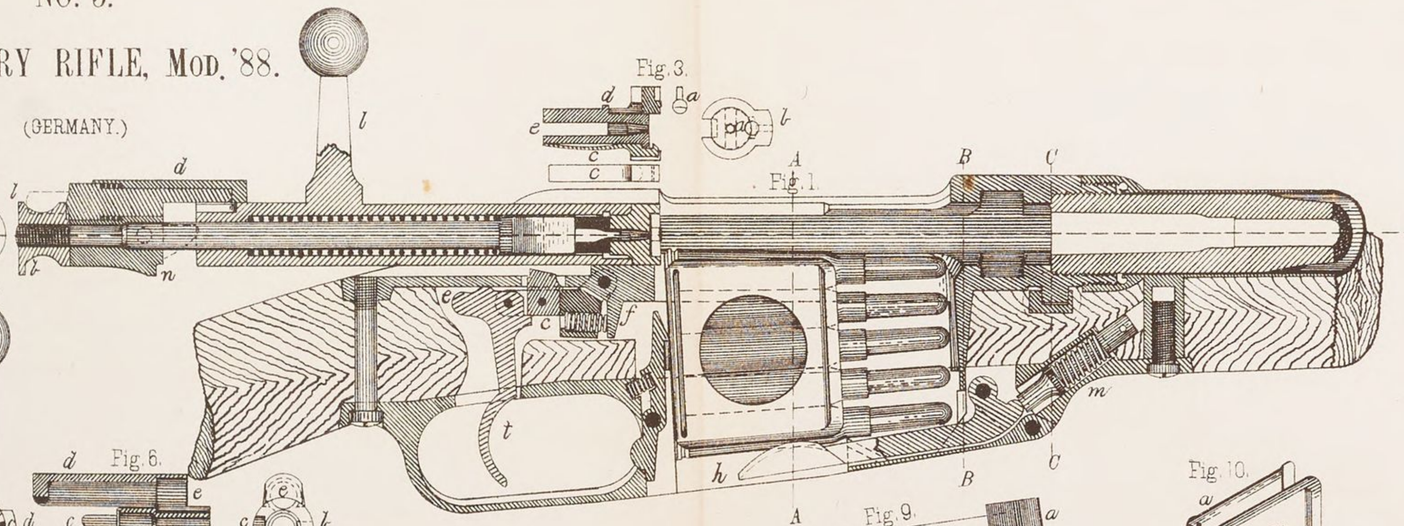
(GERMANY.)

Fig. 3.

Fig. 4.

Fig. 5.

Fig. 1.



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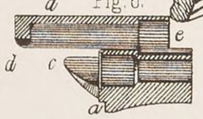

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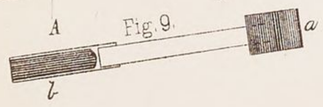

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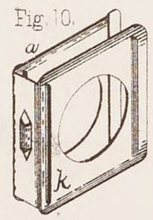

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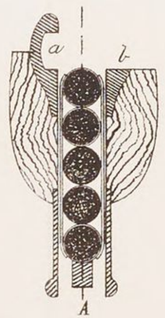

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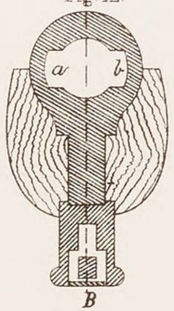

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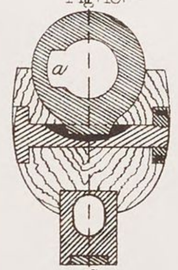

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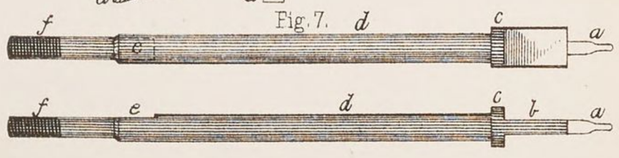

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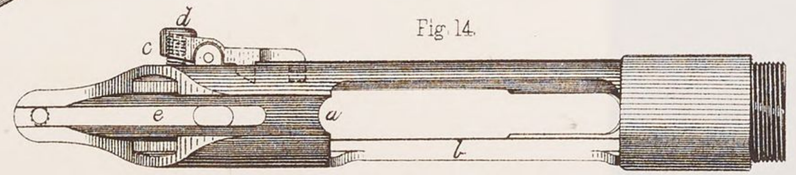

Fig. 8.

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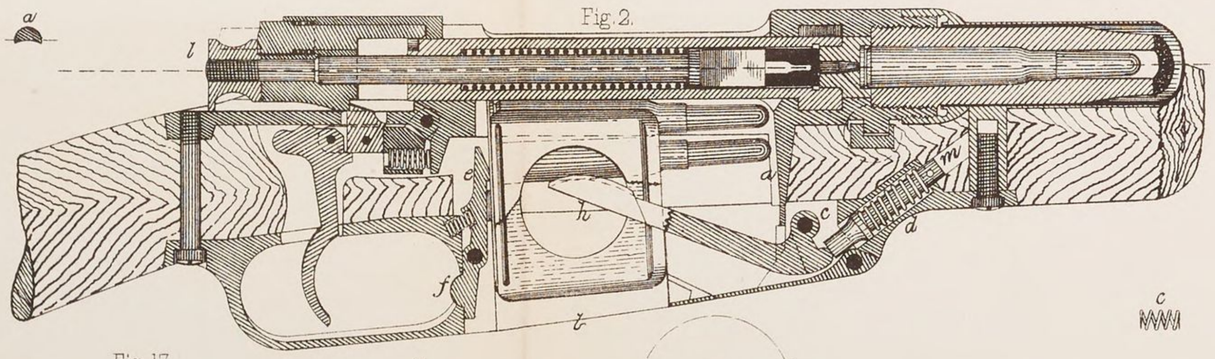

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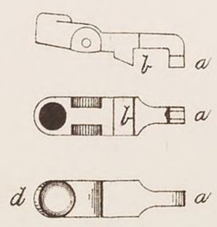

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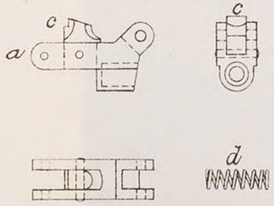

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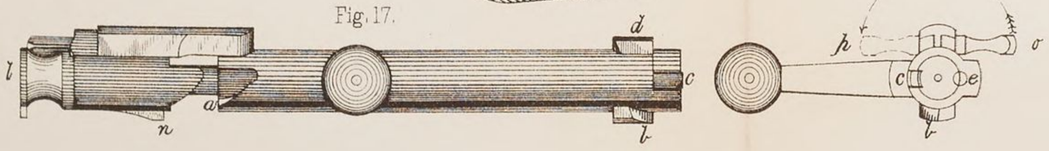

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NO. 6.

PLATE VI.

KROPATSCHEK.

(PORTUGAL.)

Fig. 4

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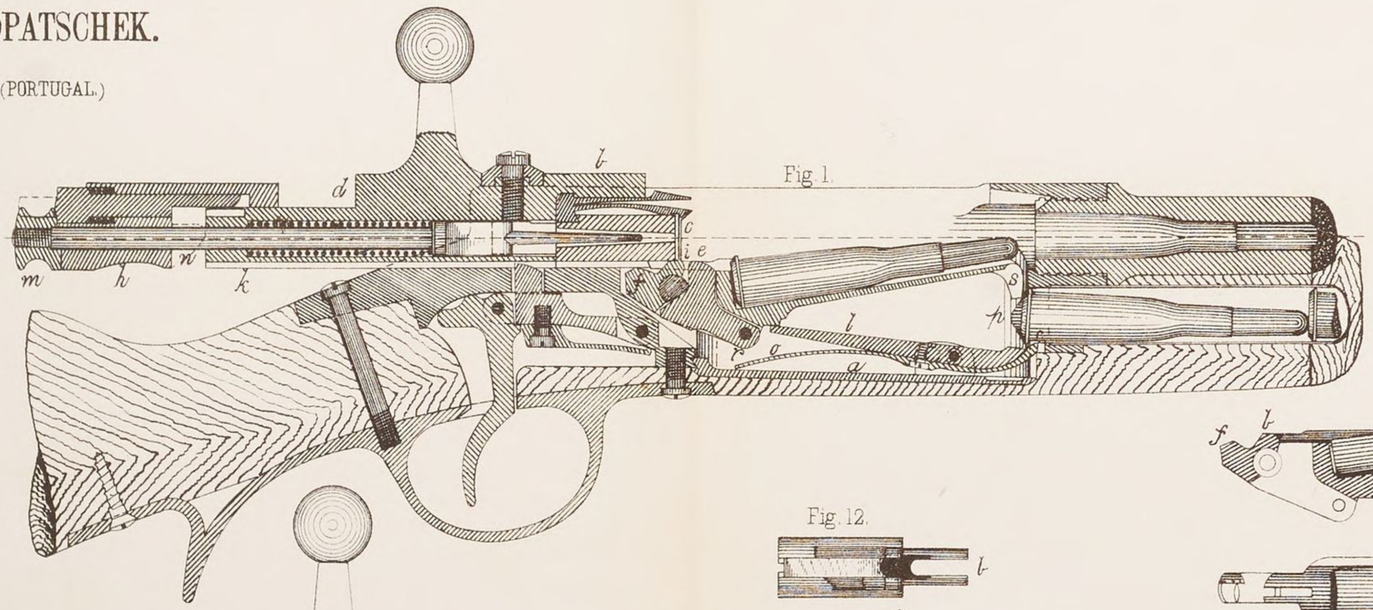

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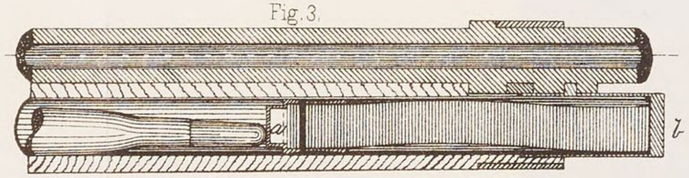


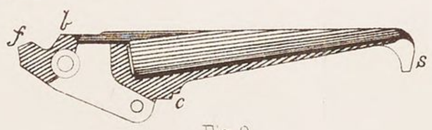


Fig. 9.

Fig. 10.

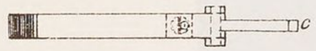


Fig. 12.

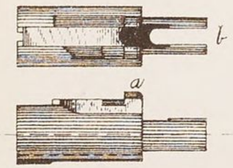
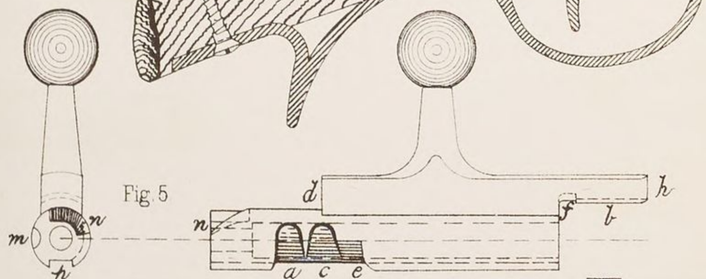


Fig. 5



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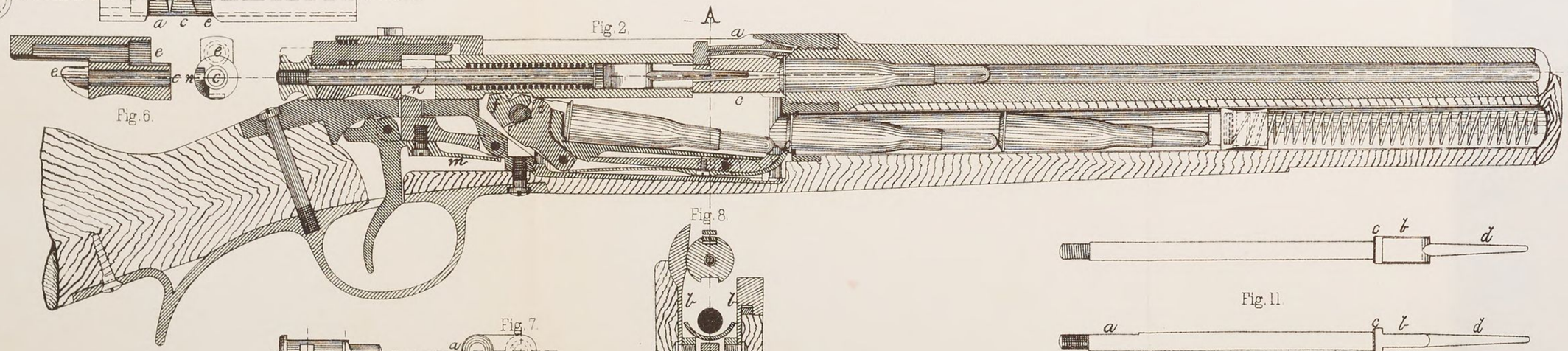
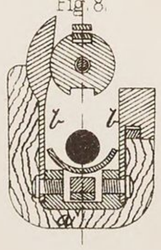


Fig. 6.

Fig. 8.



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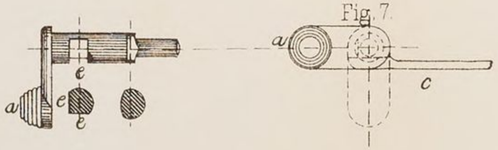

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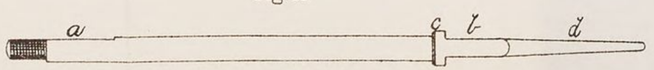

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NO. 6.

KROPATSCHEK.

(PHOTOGRAPH.)

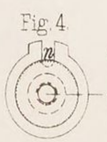
NO. 7.

PLATE VII.

MURATA.

(JAPAN.)

Fig. 4.



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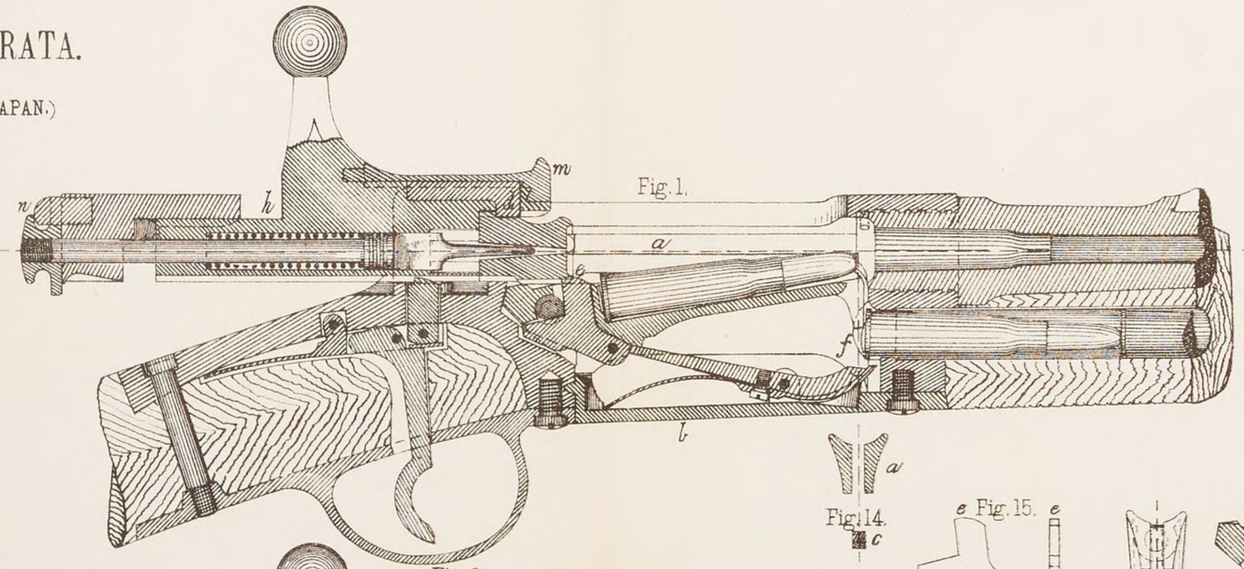

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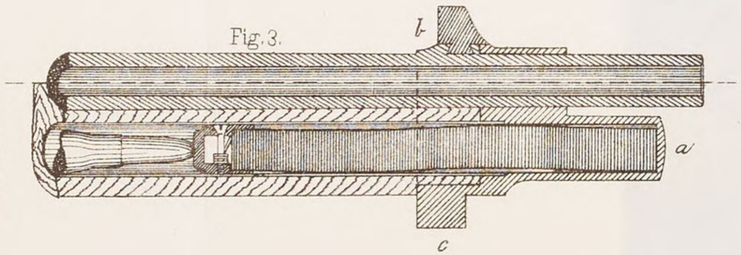
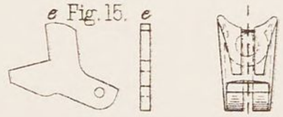


Fig. 14.

Fig. 15.



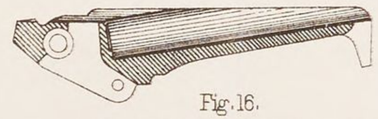


Fig. 16.

Fig. 17.

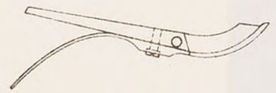


Fig. 6.

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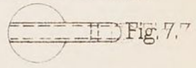

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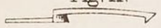

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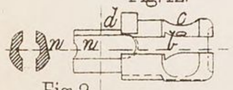

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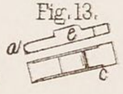

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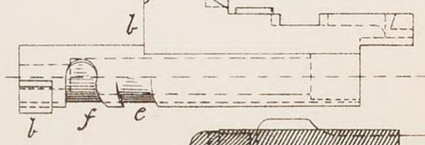

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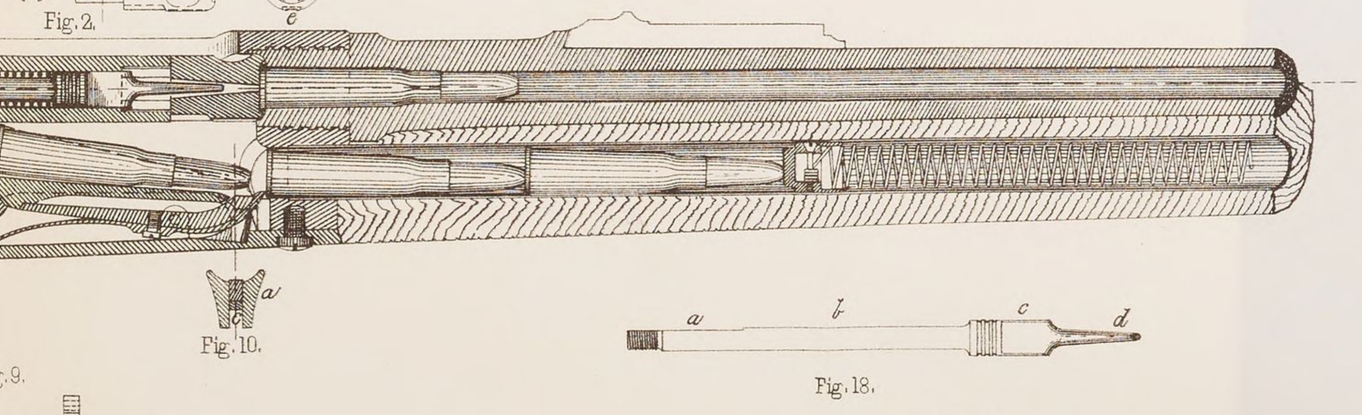


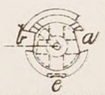
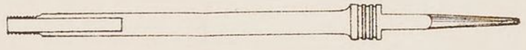


Fig. 10.

Fig. 18.



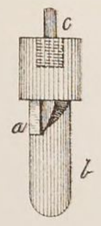


Fig. 8.

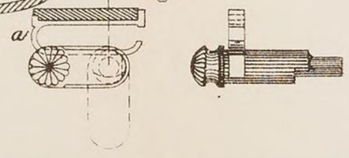


Fig. 9.

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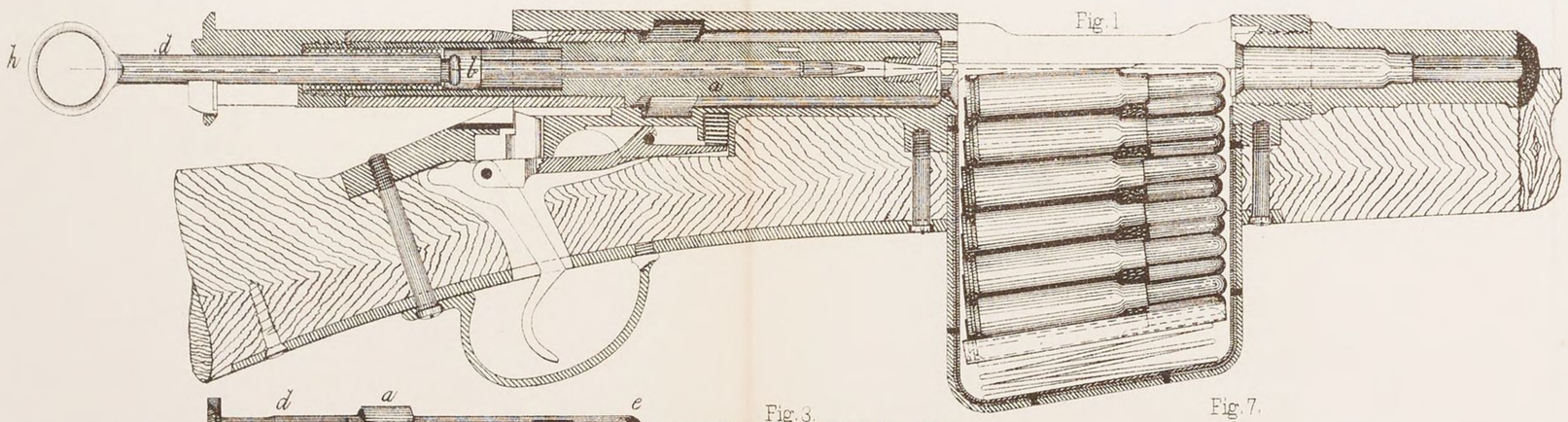
NO. 8.

PLATE VIII.

SCHMIDT.

(SWITZERLAND.)

Fig. 1



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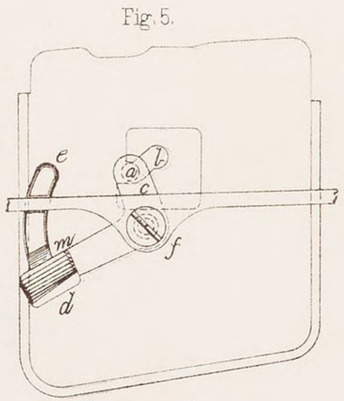

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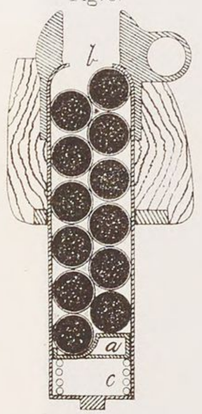

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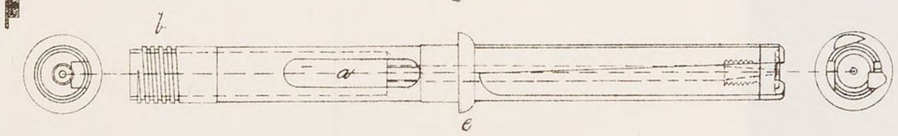

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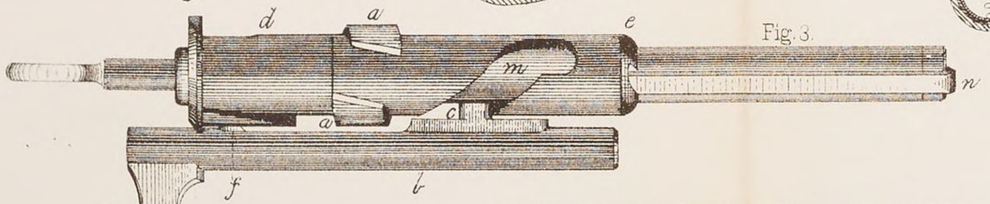
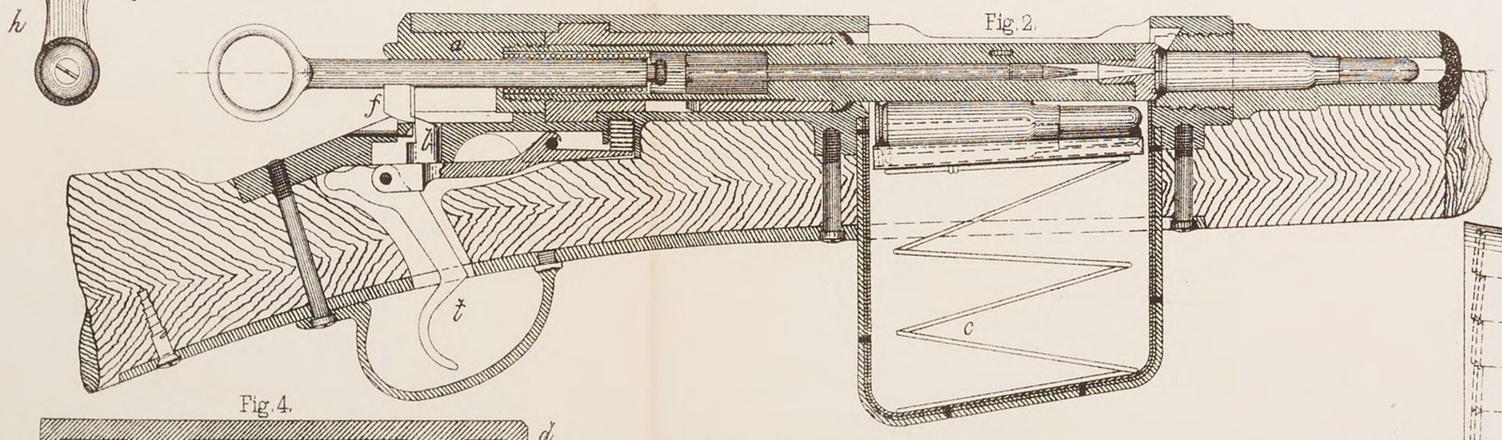


Fig. 7.

Fig. 2.



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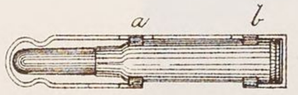

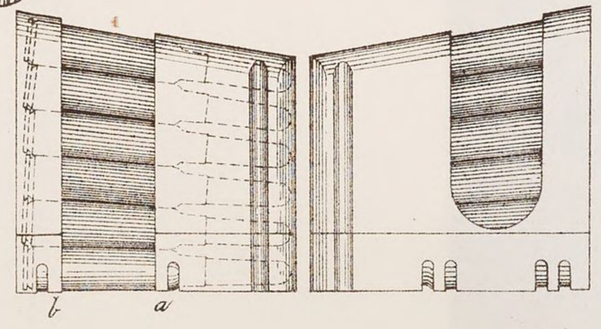

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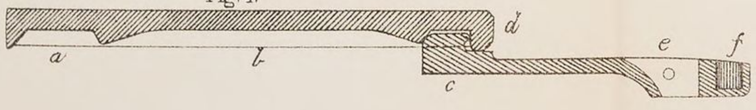

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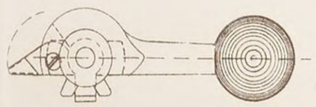
NO. 9.

PLATE IX.

MANNLICHER CARBINE.

(AUSTRIA)

Fig. 3.



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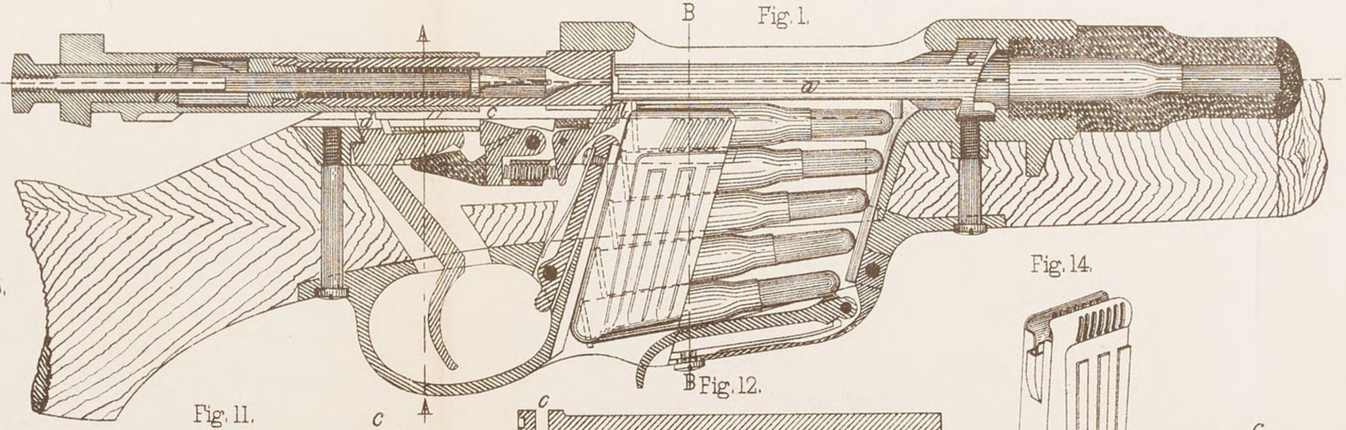


Fig. 4.

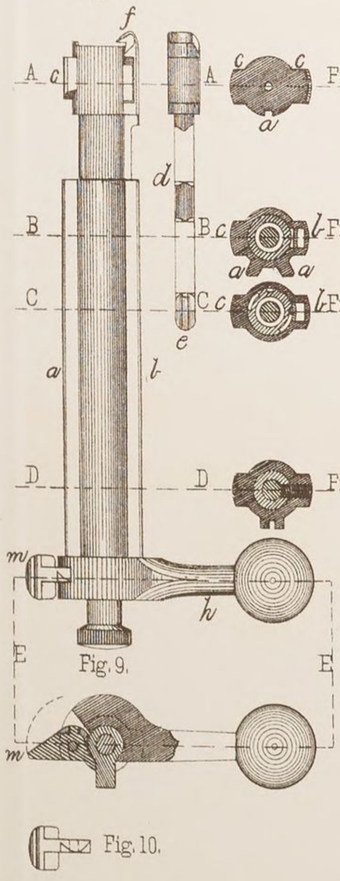


Fig. 5.

Fig. 6.

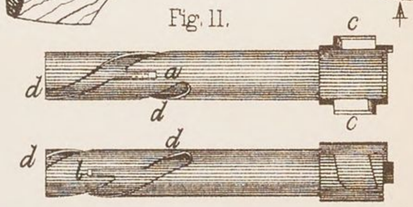
Fig. 7.

Fig. 8.

Fig. 9.

Fig. 10.

Fig. 11.



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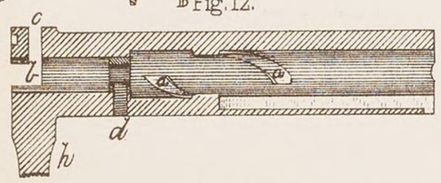

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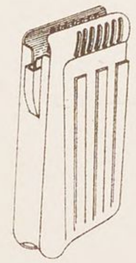

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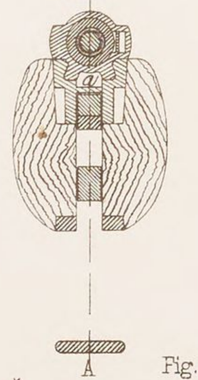


Fig. 17.

Fig. 15.

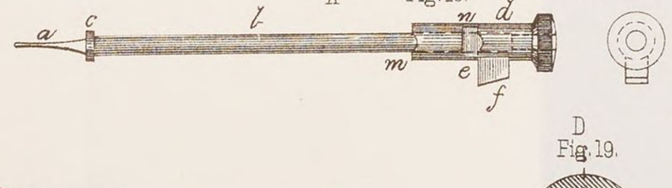
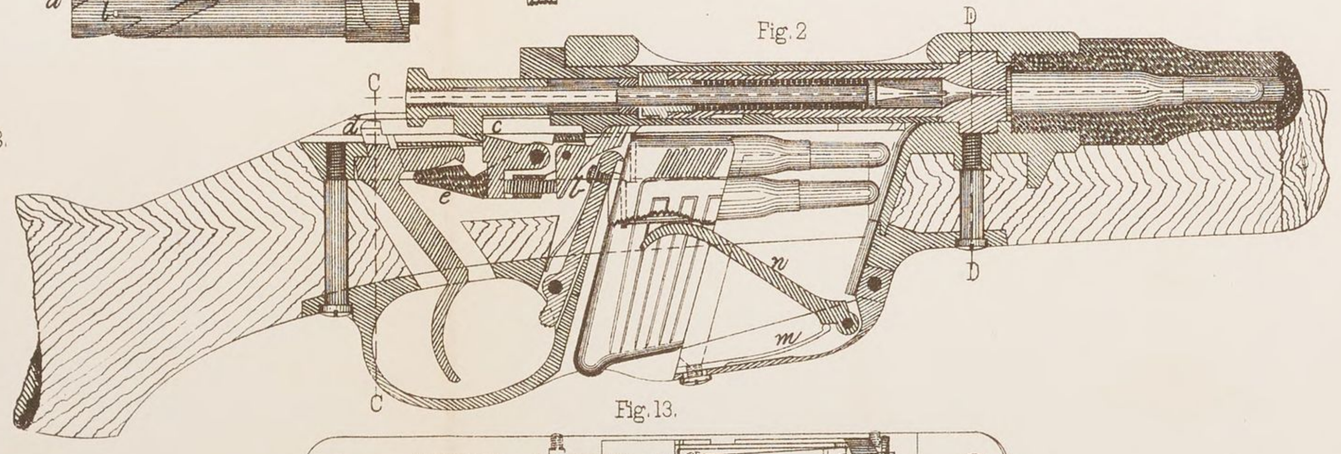


Fig. 2



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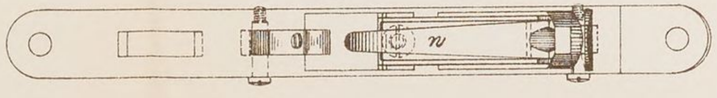

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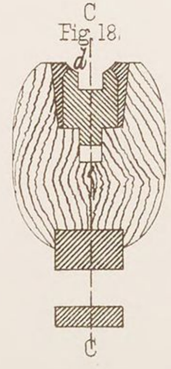

Fig. 19.

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NO. 10.

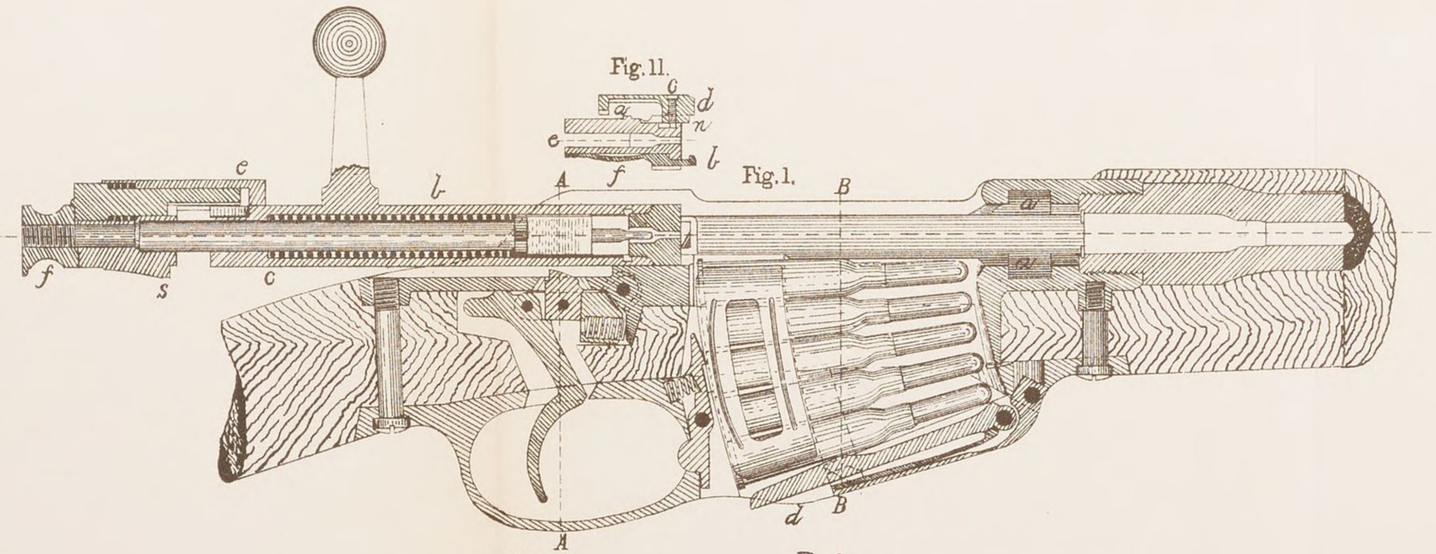
PLATE X.

MANNLICHER.

(ROUMANIA)

Fig. 11.

Fig. 1.



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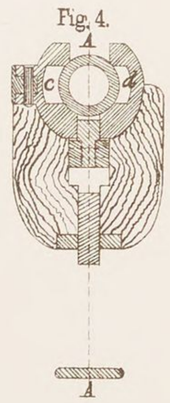

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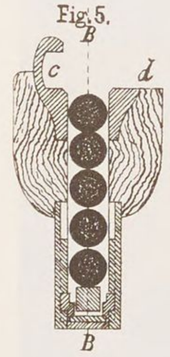
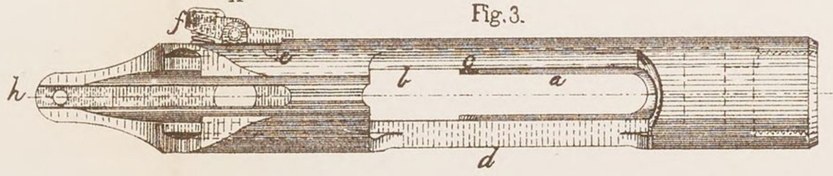


Fig. 6.

Fig. 7.

Fig. 8.

Fig. 3.



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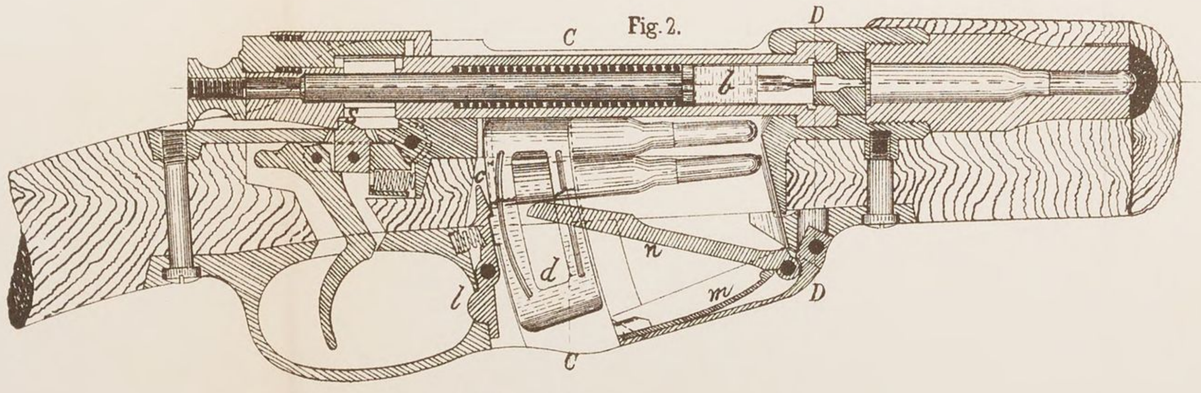

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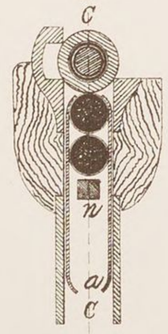
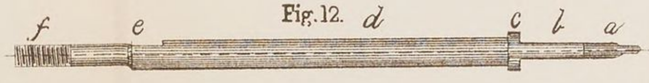


Fig. 10.

Fig. 12.



Appendix 9, 1892,

NO. 12.

PLATE XII.

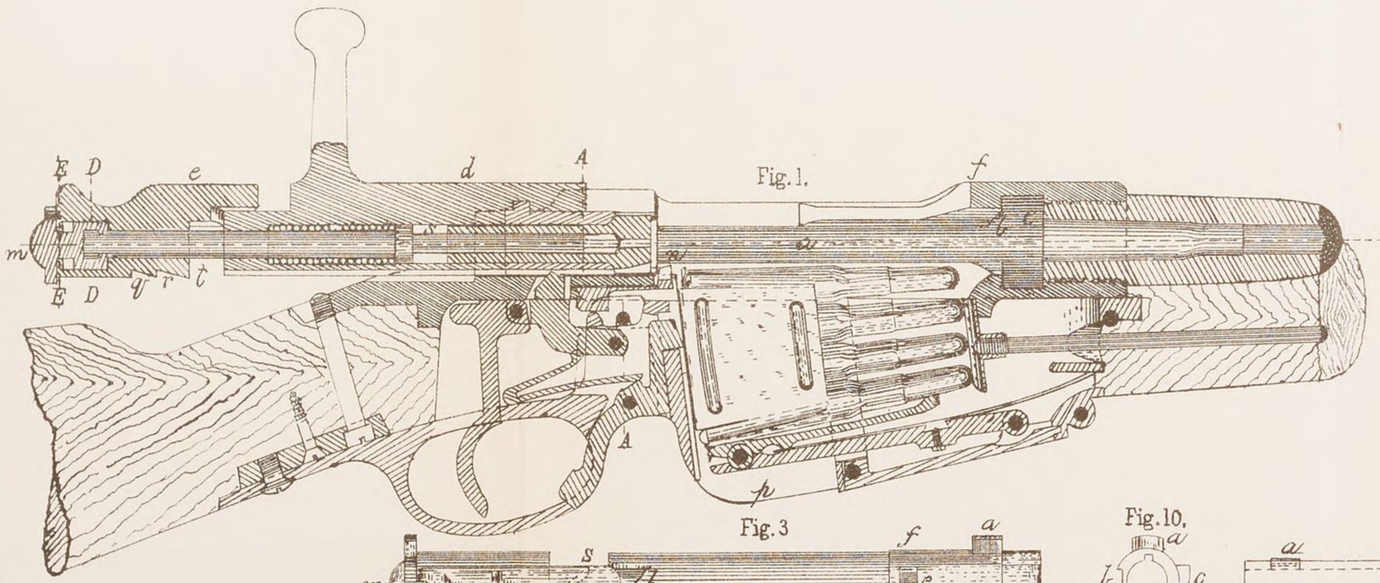
BERTHIER.

(FRANCE.)

Fig. 6.

Fig. 5.

Fig. 1.



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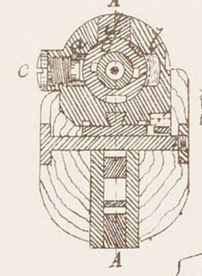

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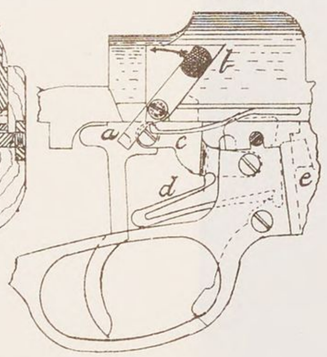

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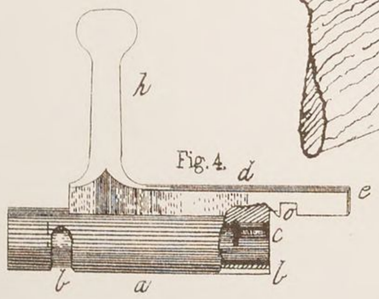


Fig. 3

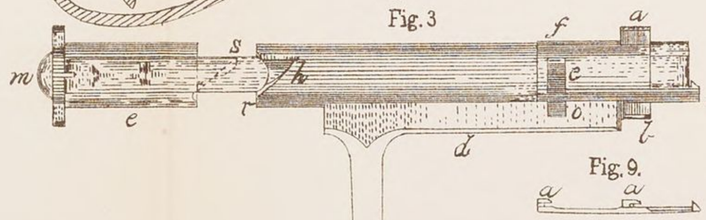


Fig. 10.

Fig. 11.

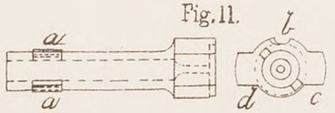
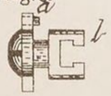


Fig. 9.

Fig. 7.

Fig. 8.



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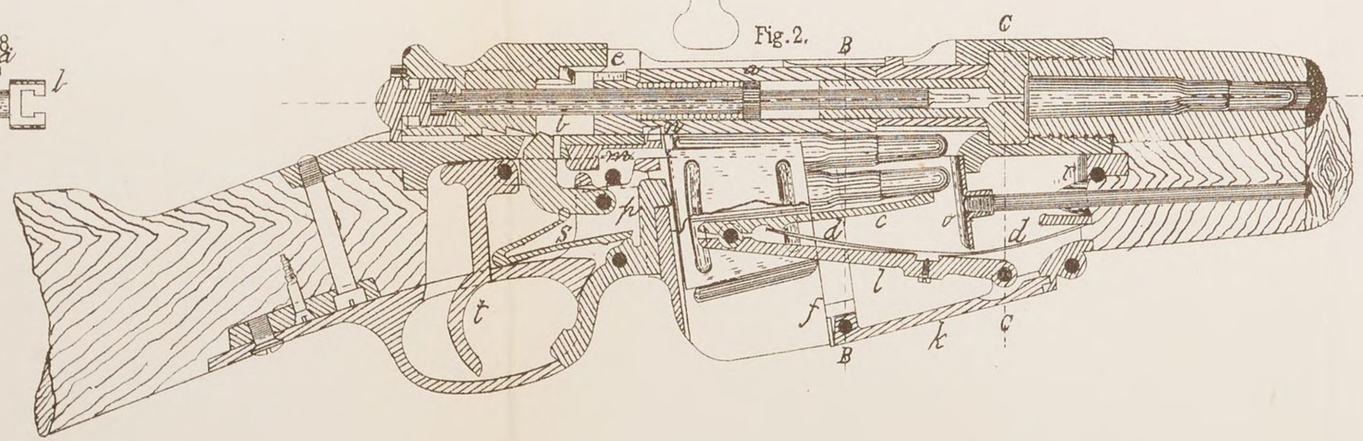

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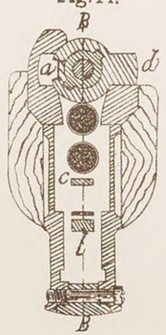

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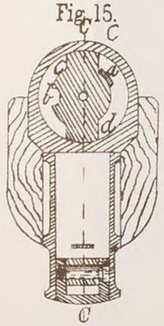

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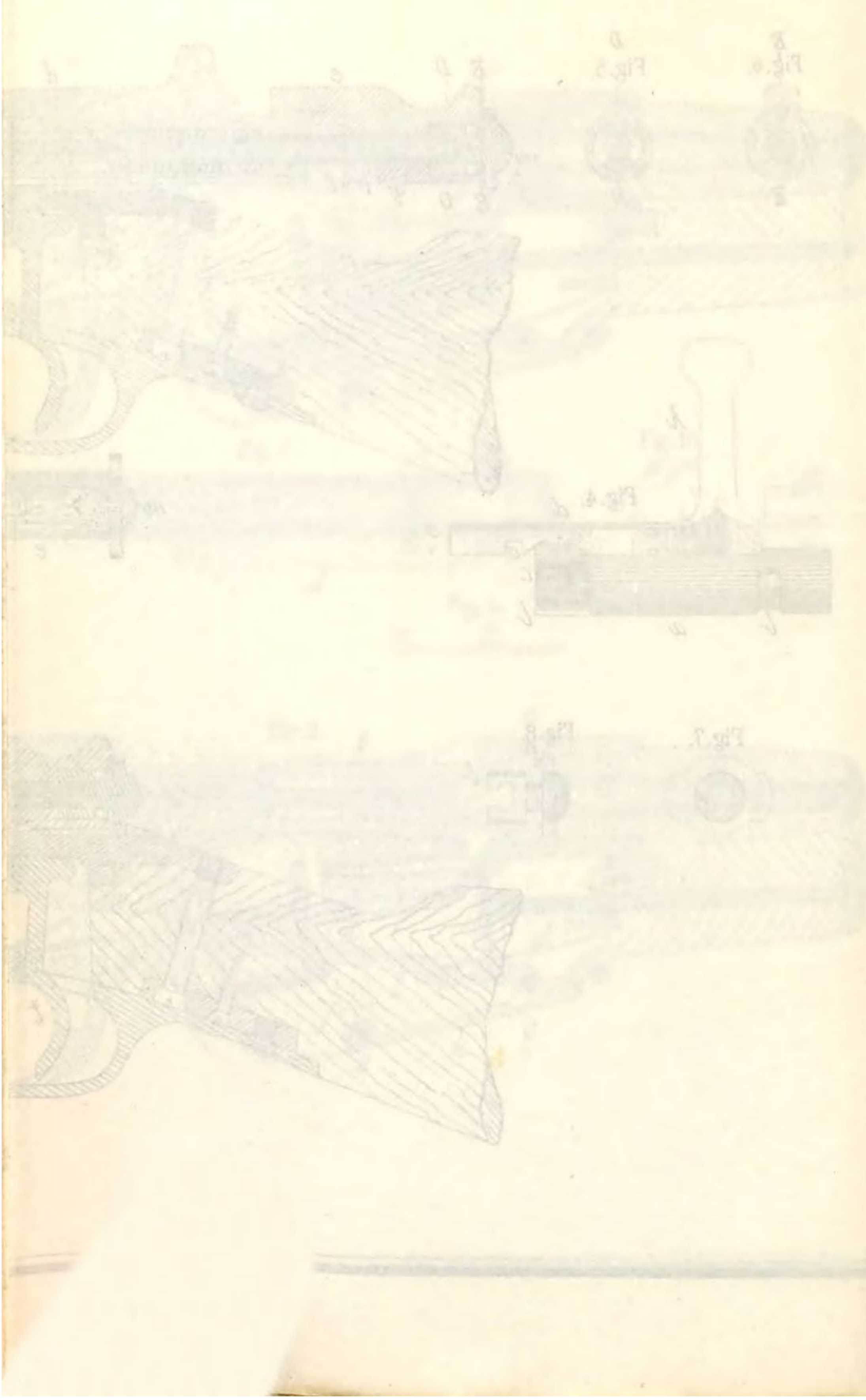
NO. 12.

BERTHIER.

(FRANCE.)



NO. 14.

PLATE XIII.

SPORER.

Fig. 3.

Fig. 1.

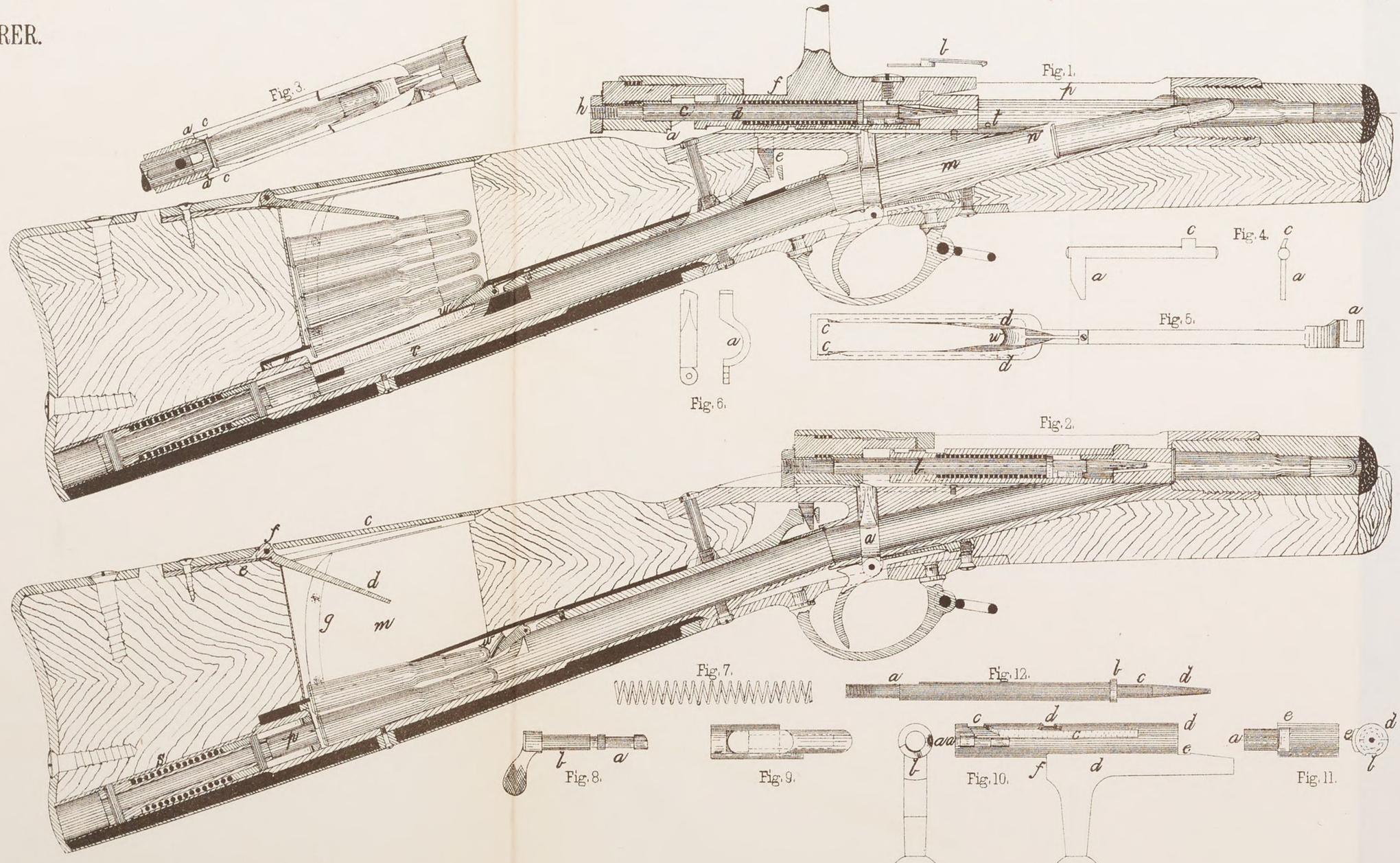


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 2.

Fig. 7.

Fig. 12.

Fig. 8.

Fig. 9.

Fig. 10.

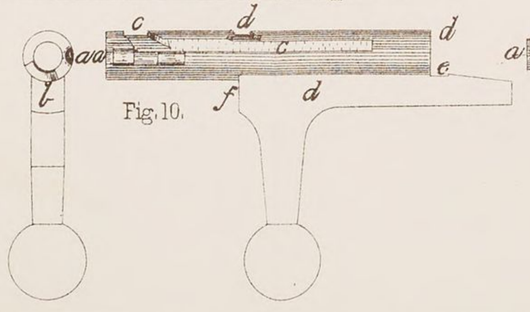


Fig. 11.

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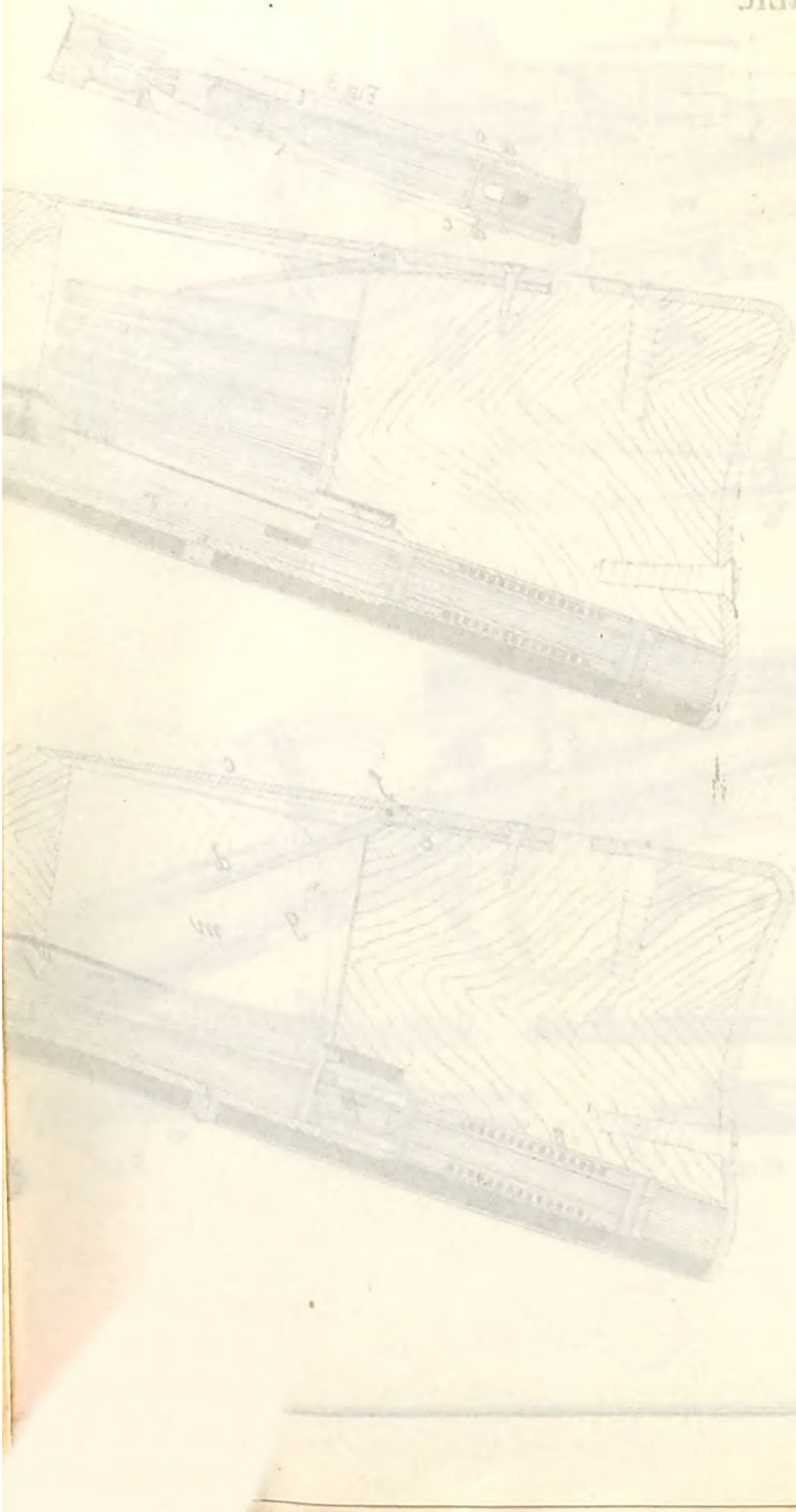
NO. 14.

SPOKER.



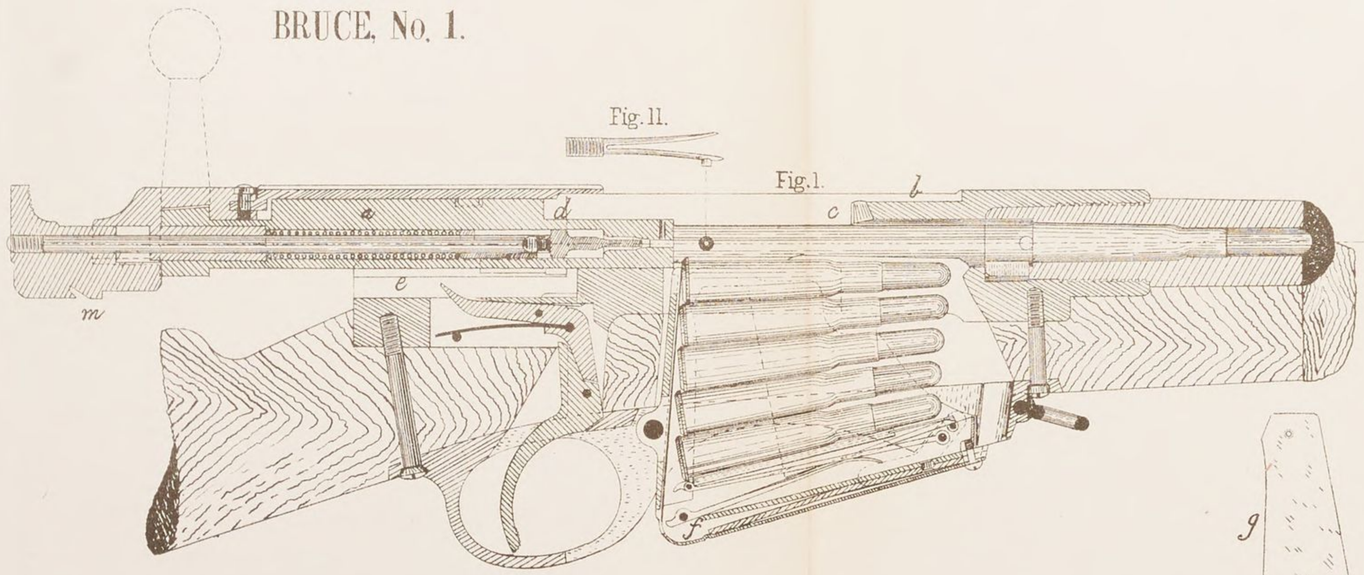
NO. 15.

PLATE XIV.

BRUCE, No. 1.

Fig. 11.

Fig. 1.



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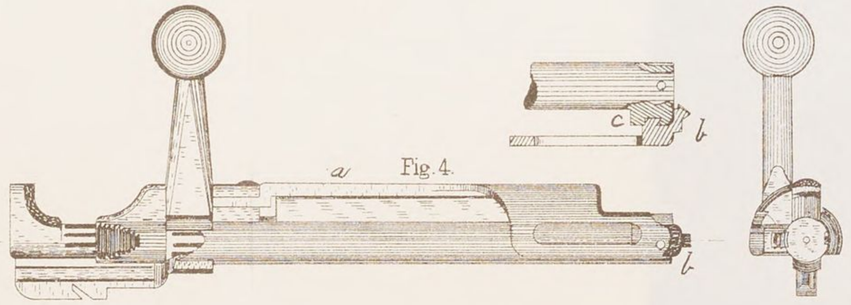

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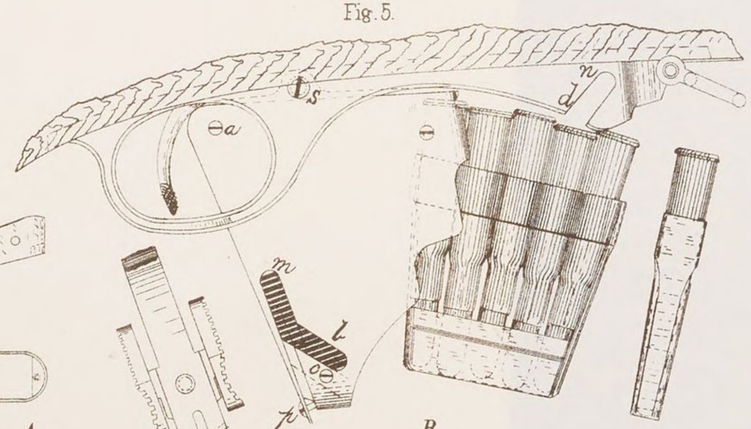


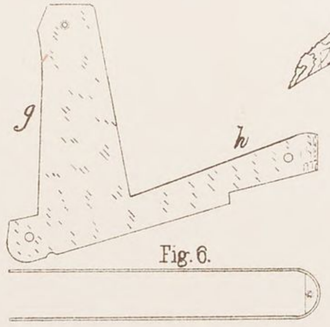
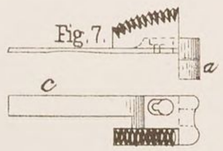


Fig. 6.

Fig. 7.



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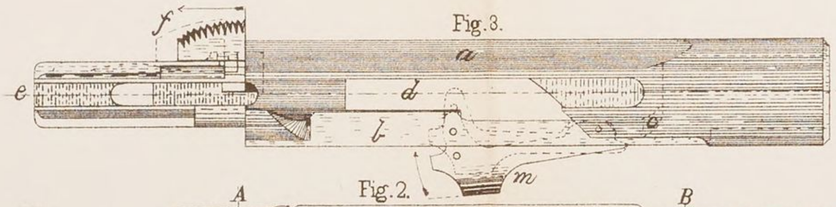
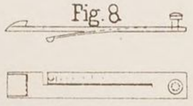


Fig. 8



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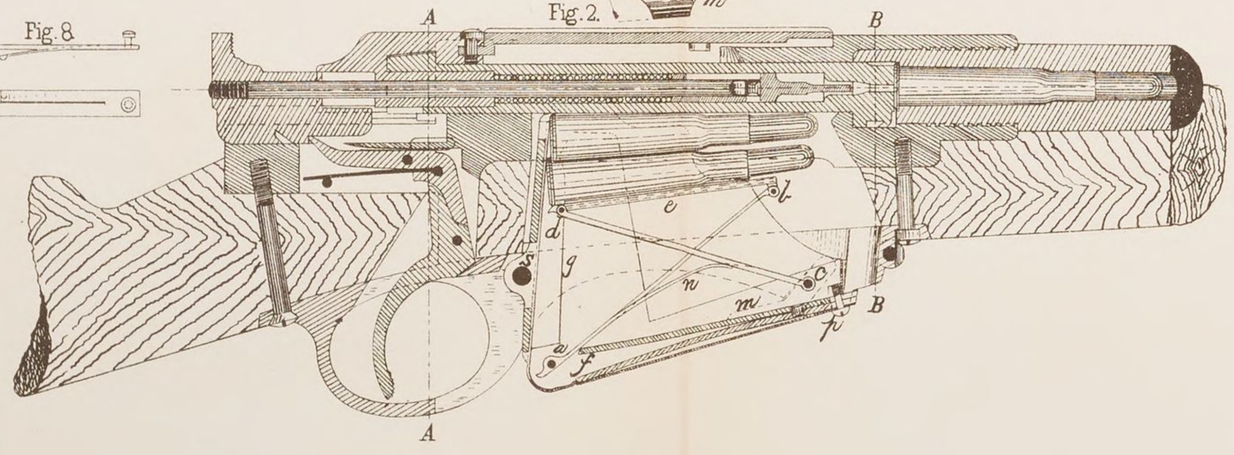

Fig. 9.

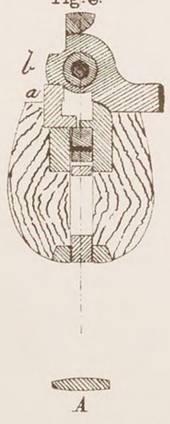

Fig. 10.

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NO. 24.
MAUSER, No. 3.

Fig. 1.

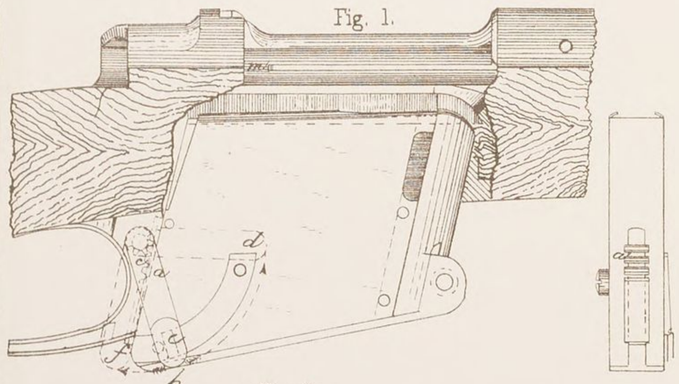
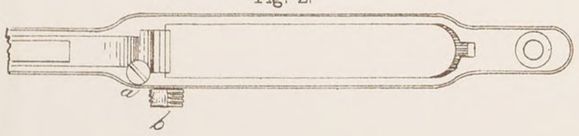


Fig. 2.



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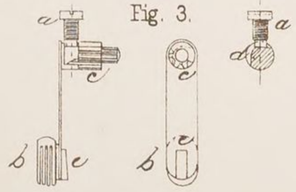

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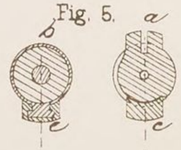


Fig. 4.

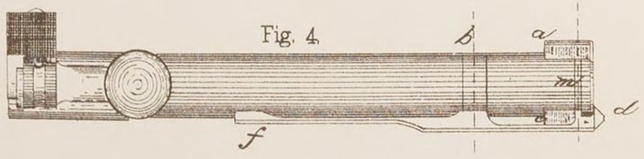


Fig. 6.

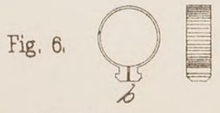
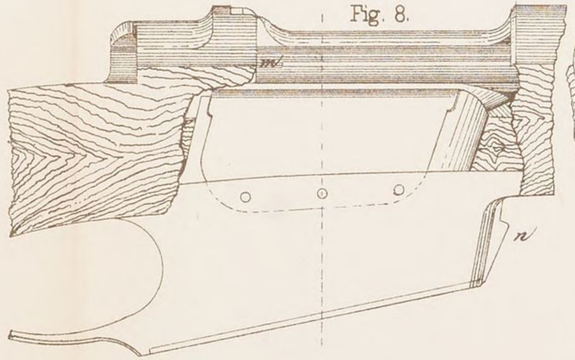


Fig. 7.

NO. 27.
MAUSER, No. 4.

Fig. 8.



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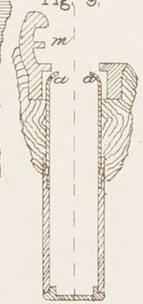

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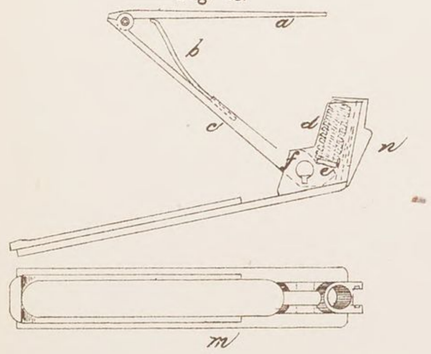

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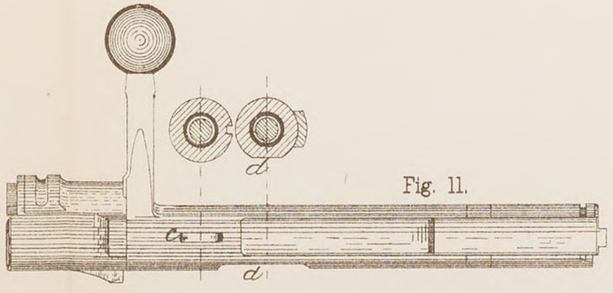
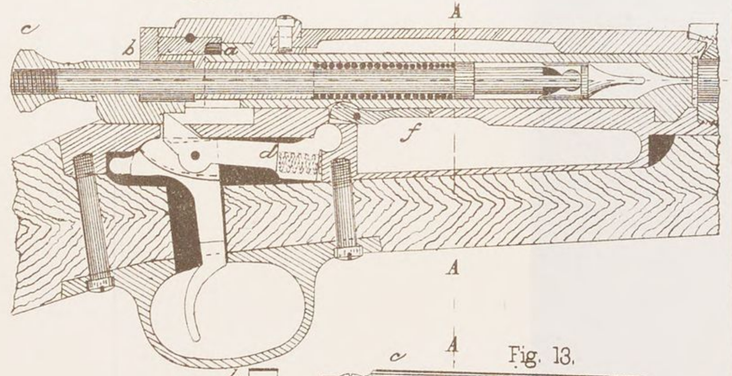


NO. 28.
KRAG-JORGENSEN, No. 5.

Fig. 12.



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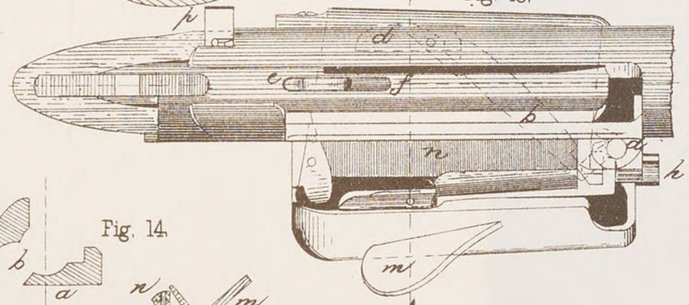

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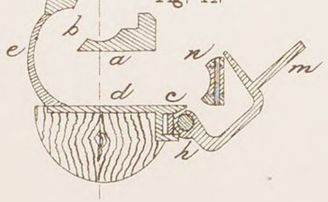

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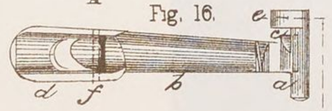

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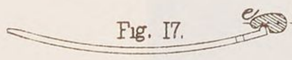

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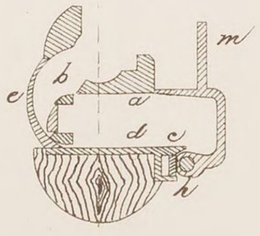

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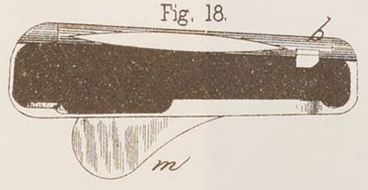

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NO. 40.

HAMPDEN, No. 2.

PLATE XVI.

Fig. 1.

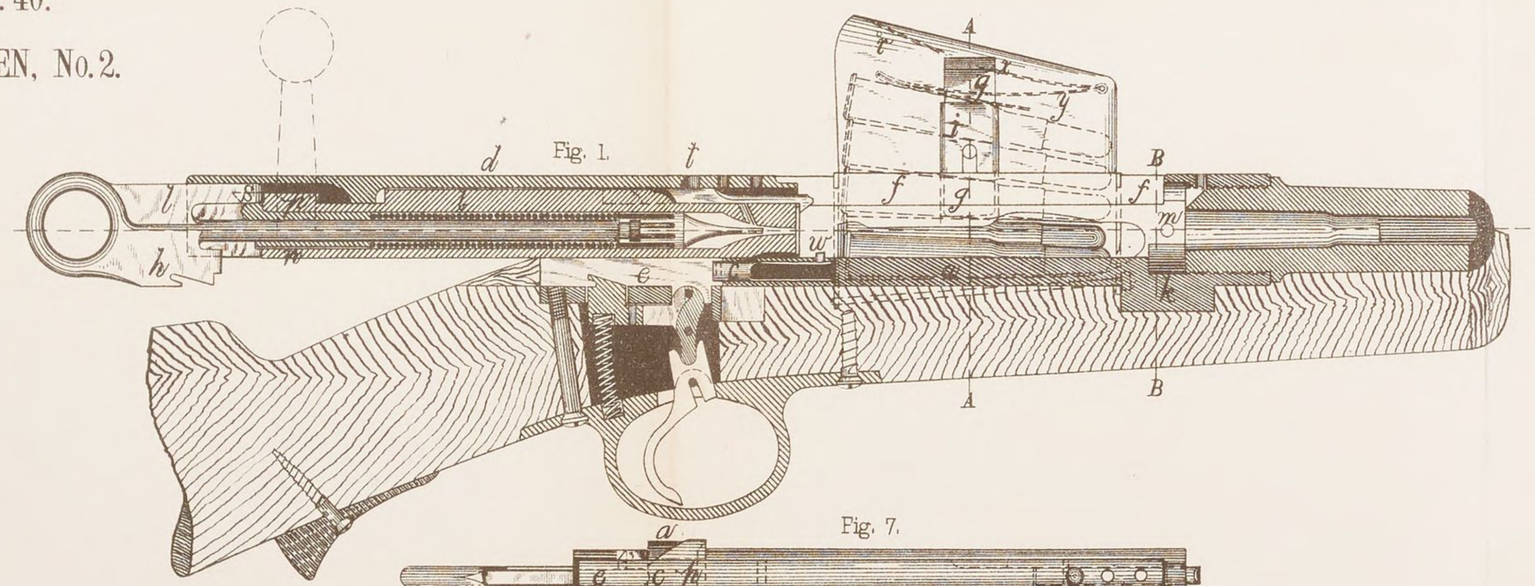


Fig. 3.

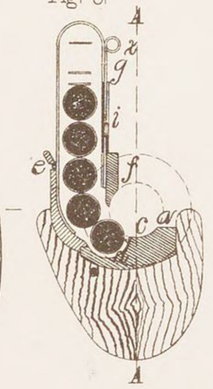
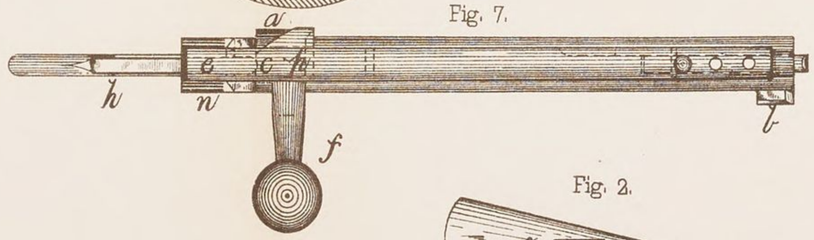


Fig. 4.

Fig. 7.



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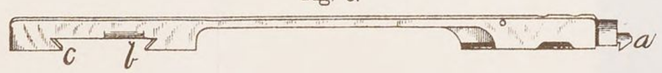


Fig. 8.

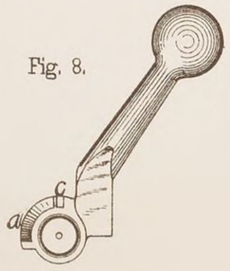
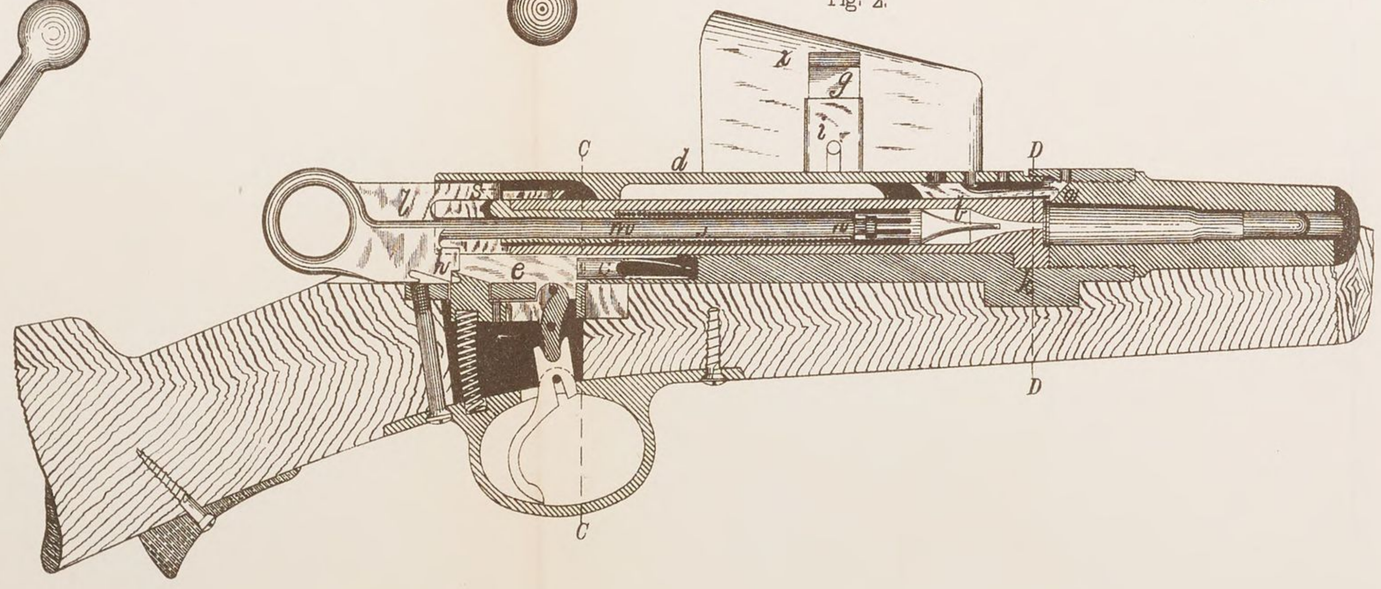
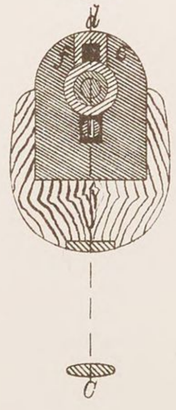


Fig. 2.



C
Fig. 5.



D
Fig. 6.

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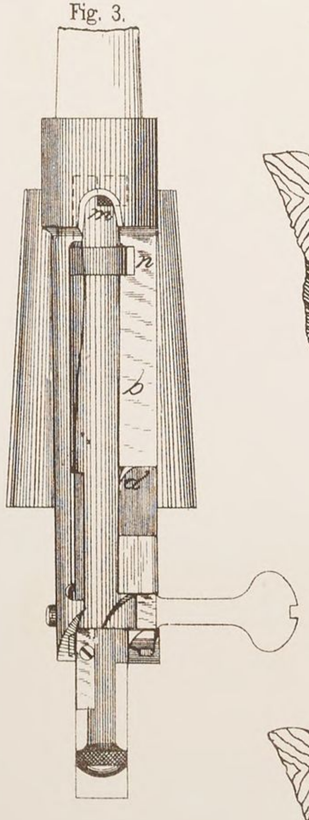
NO. 32.

DURST, No. 1.

PLATE XVII.

Fig. 3.



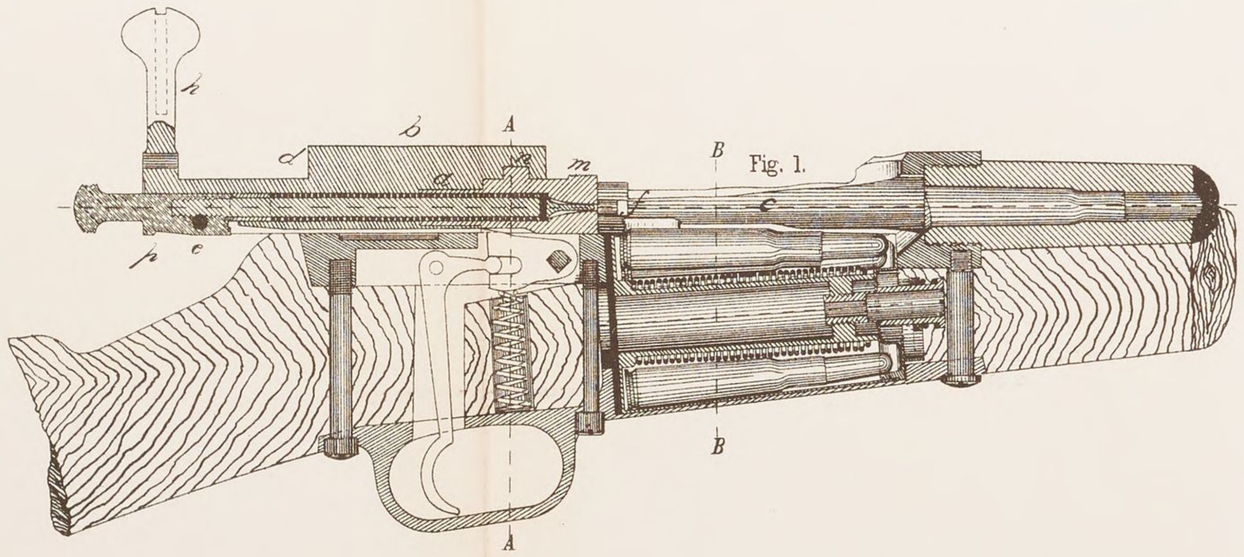
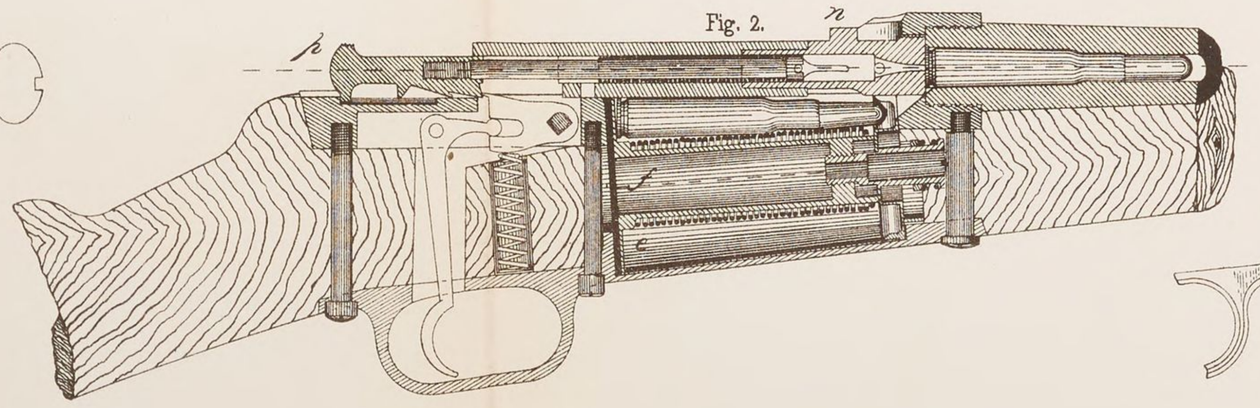


Fig. 1.

Fig. 2.



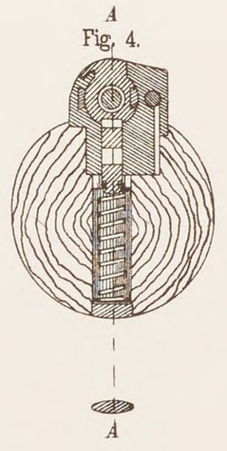


Fig. 4.

Fig. 5.

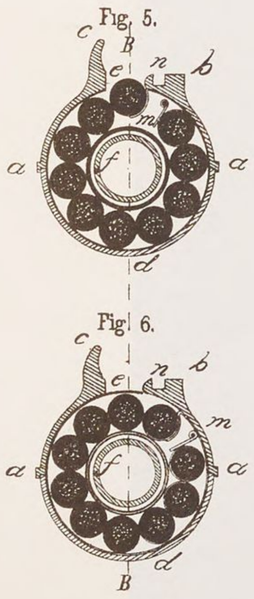
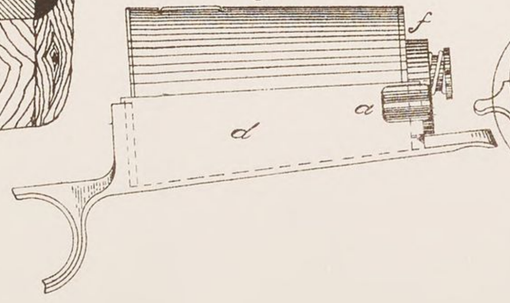


Fig. 6.

Fig. 7.



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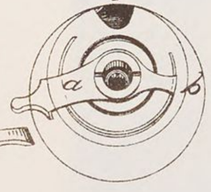


No. 32.
DUPLT. No. 1.

NO. 33.

LARSEN.

PLATE XVIII.

Fig. 1.

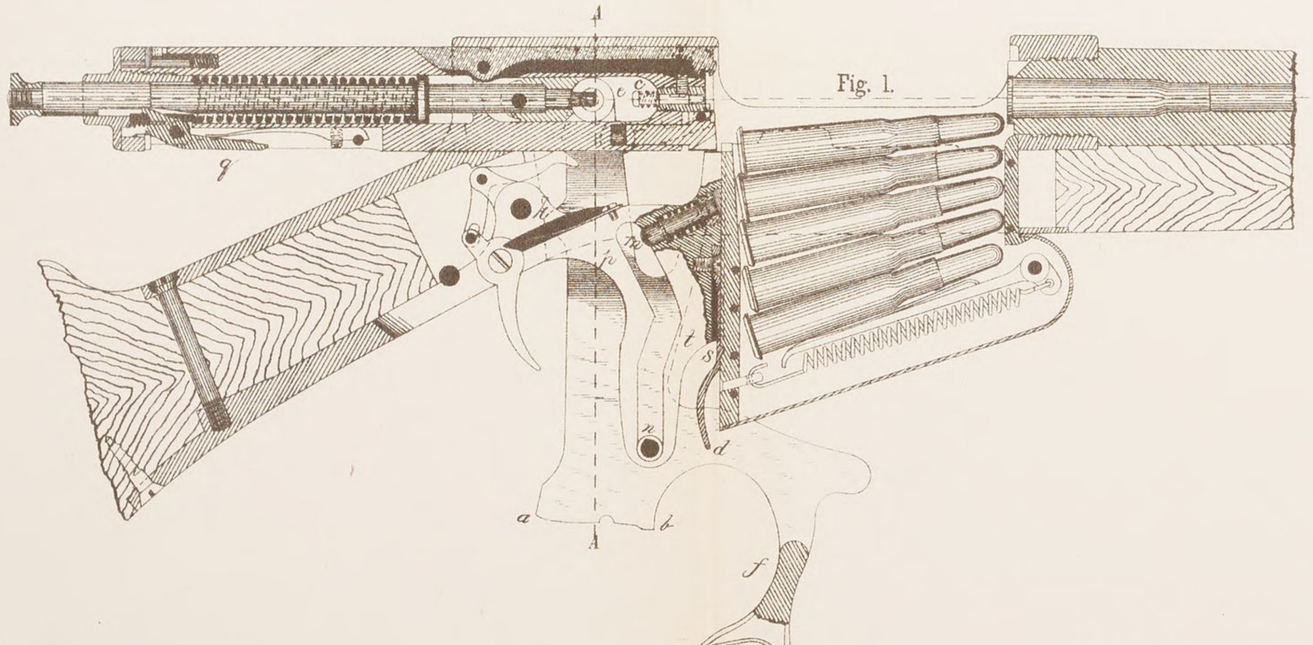


Fig. 3.

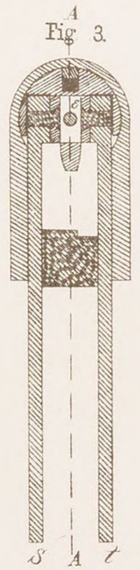
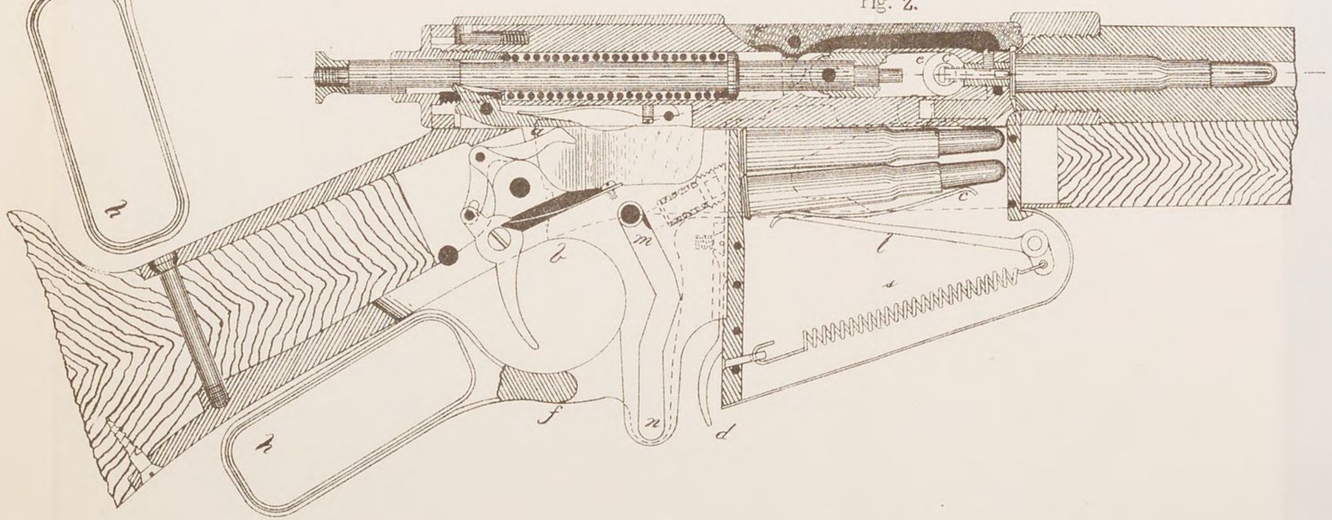


Fig. 2.



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NO. 33.

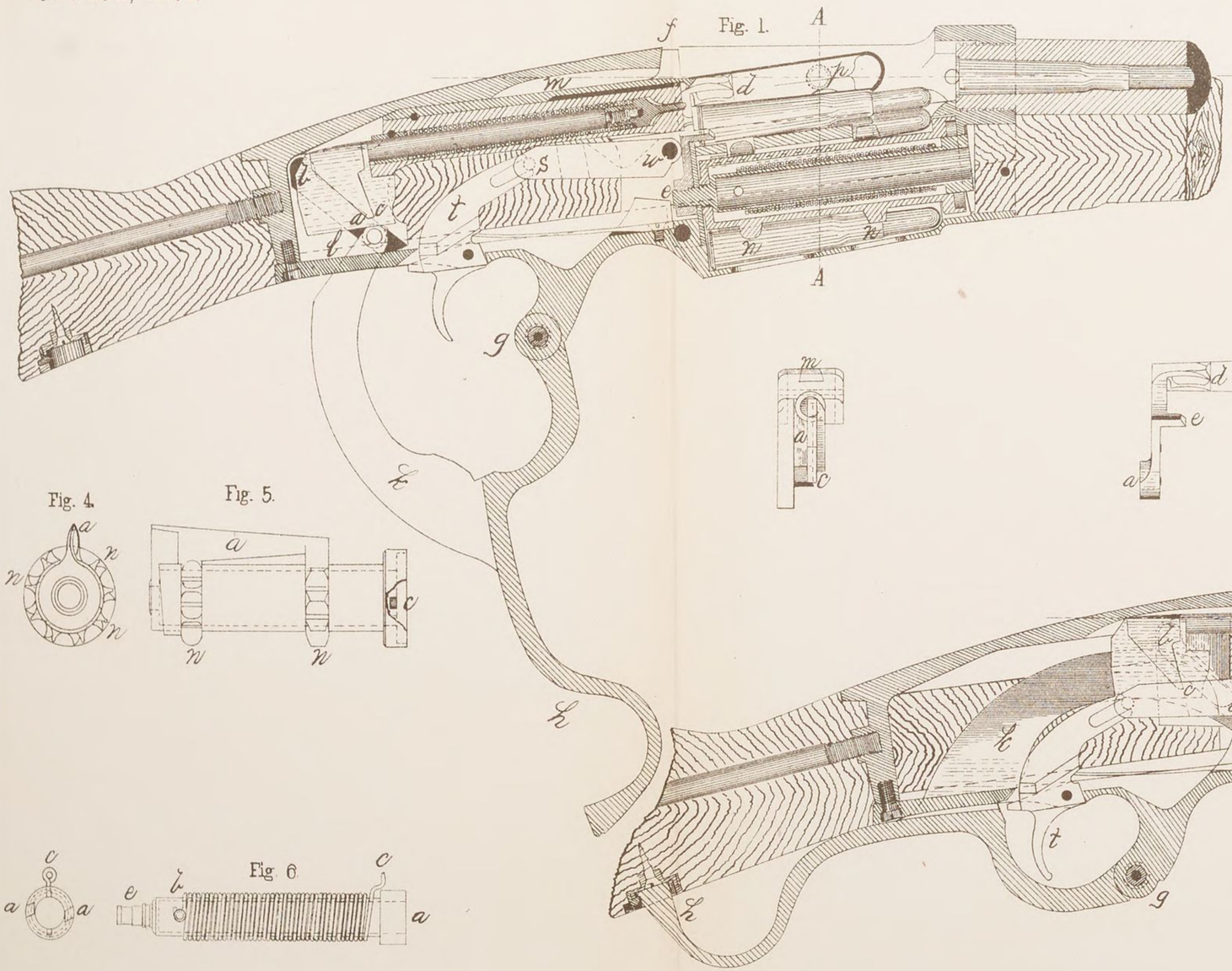
LARSEN.

NO. 35.

SAVAGE, No. 1.

PLATE XIX.

Fig. 1.



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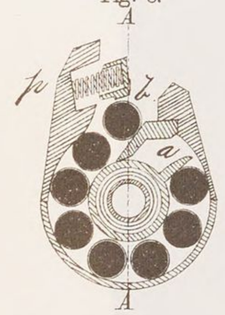


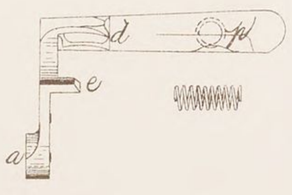
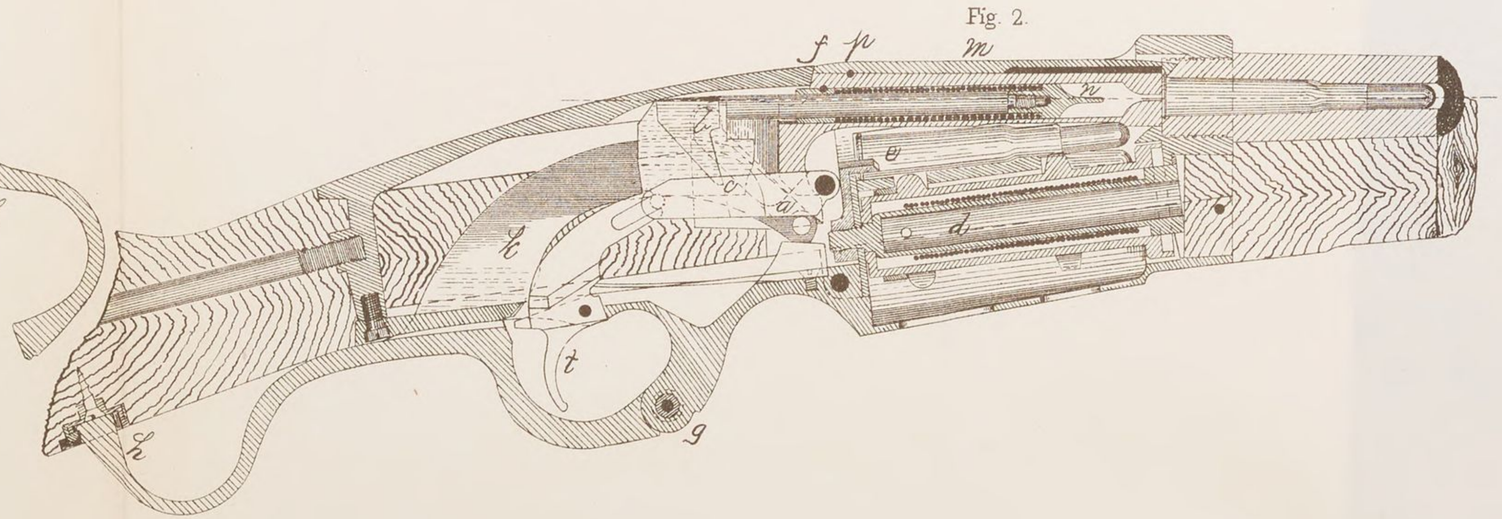


Fig. 4.

Fig. 5.

Fig. 6.

Fig. 2.



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NO. 36.

MULLINS.

PLATE XX.

Fig. 3.

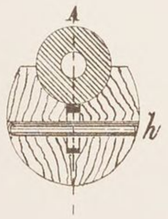
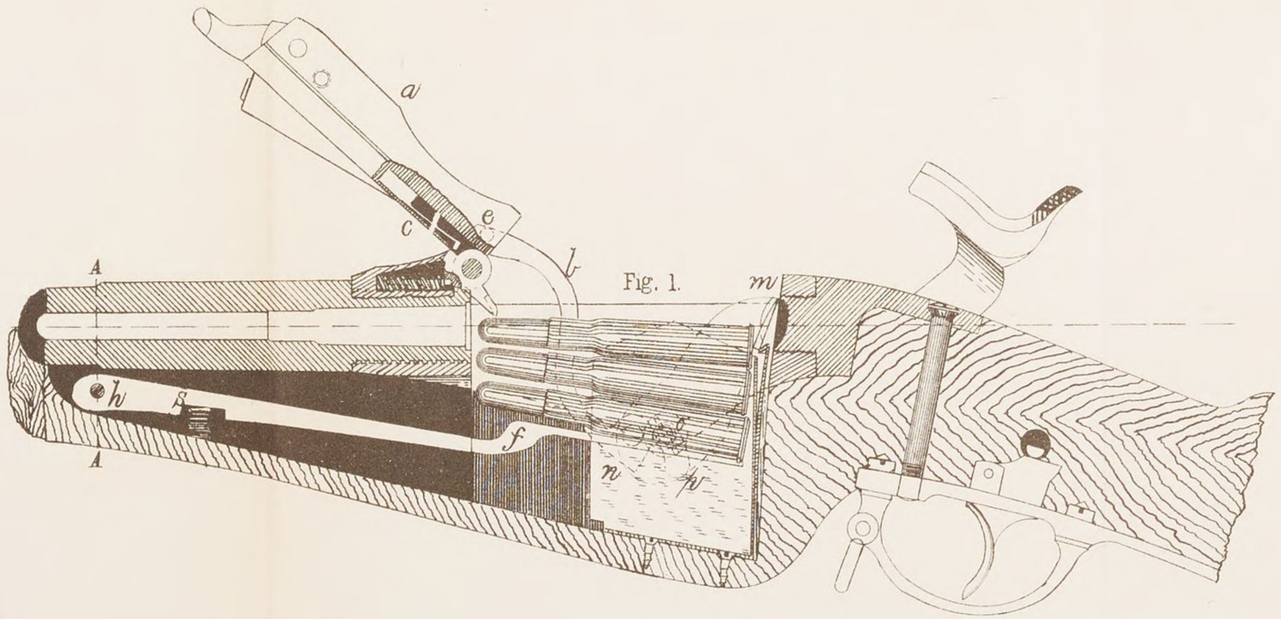


Fig. 1.



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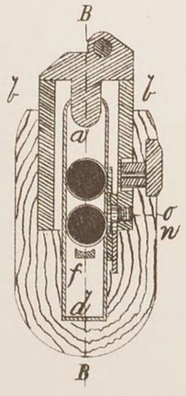

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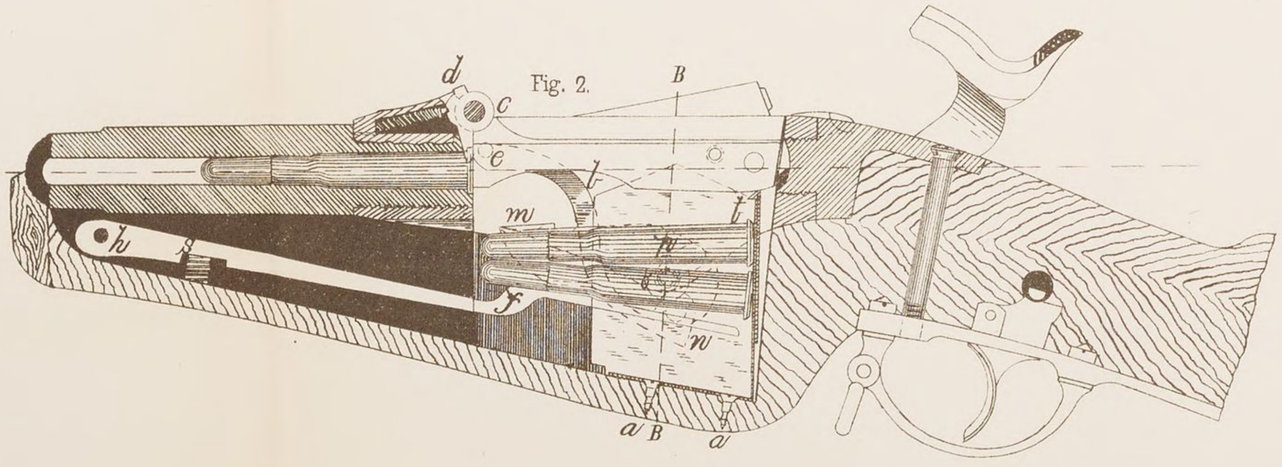

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NO.38.

PLATE XXI.

BLAKE, No.1.

Fig. 1.

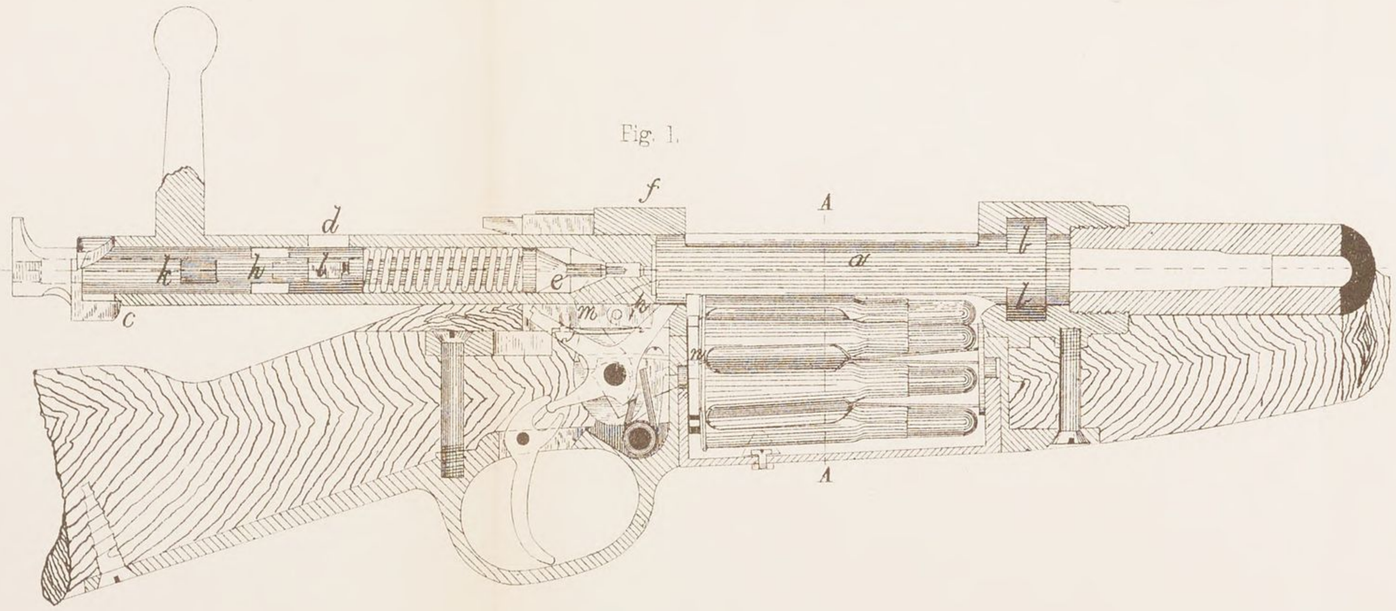

Fig. 3.

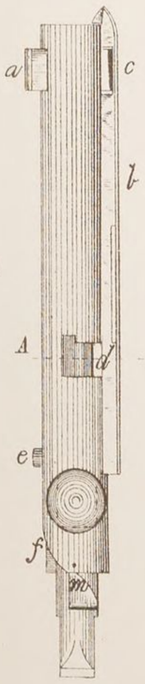

Fig. 4

Fig. 2.

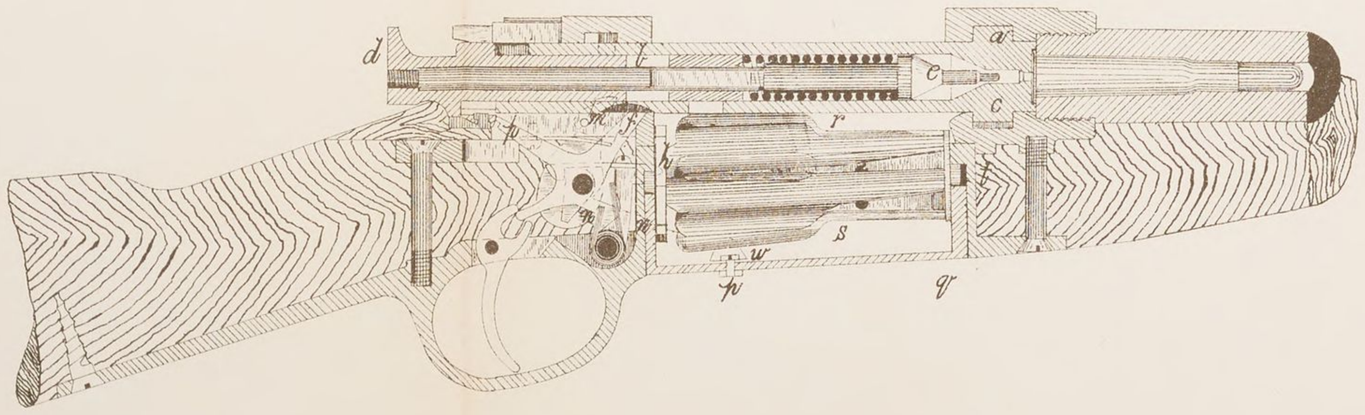

Fig. 5.

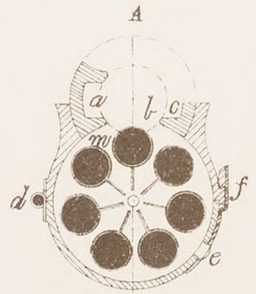

Fig. 6.

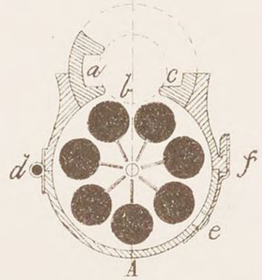

Fig. 7.

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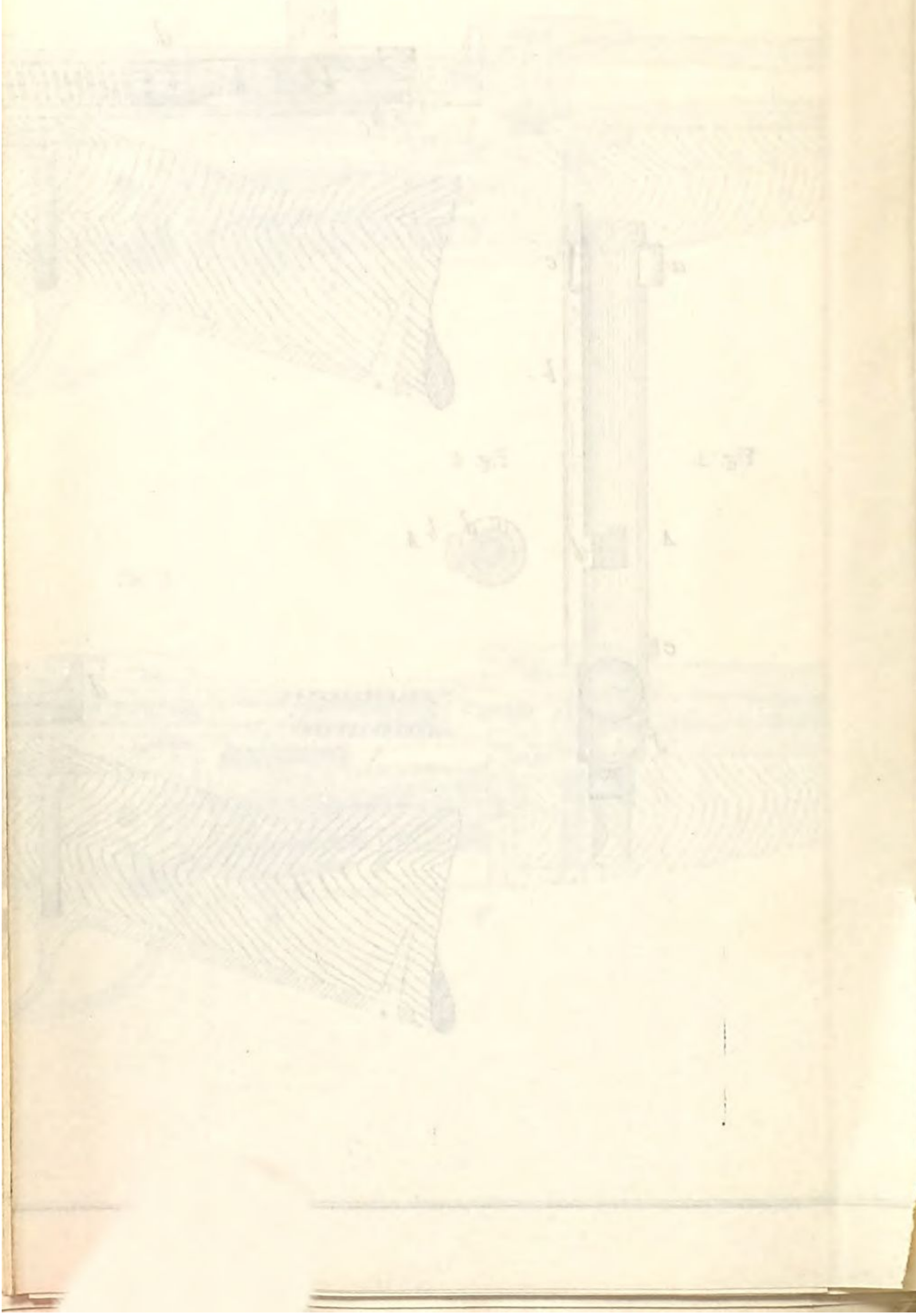
No. 35.

BLAKE, No. 1.

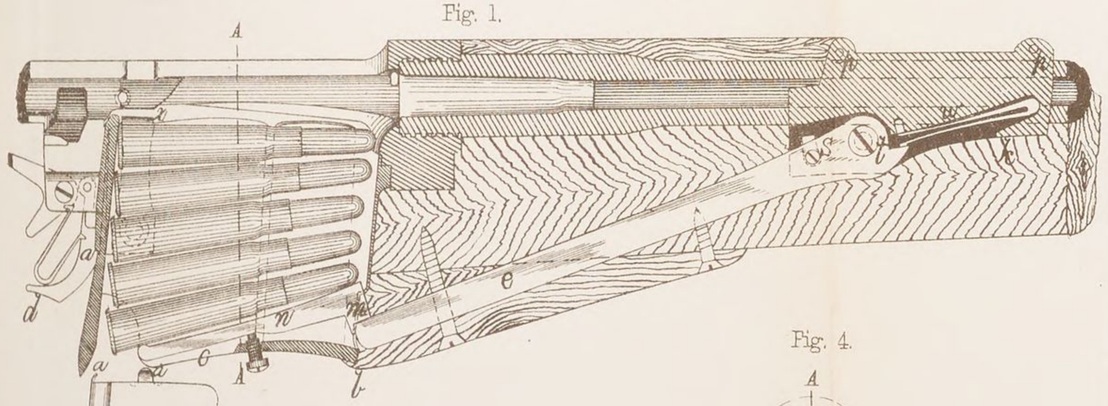


NO. 41.

RUSSELL-LIVERMORE.

No. 1.

Fig. 1.



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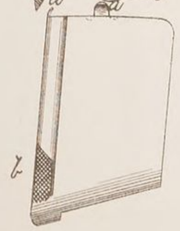

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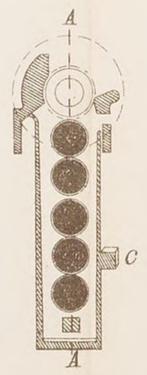

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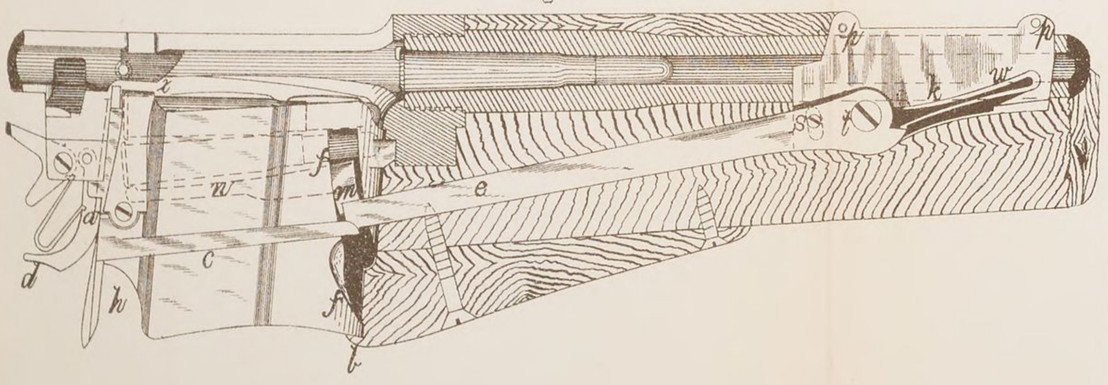


NO. 42.

PLATE XXII.

RUSSELL-LIVERMORE.

No. 2.

Fig. 1.

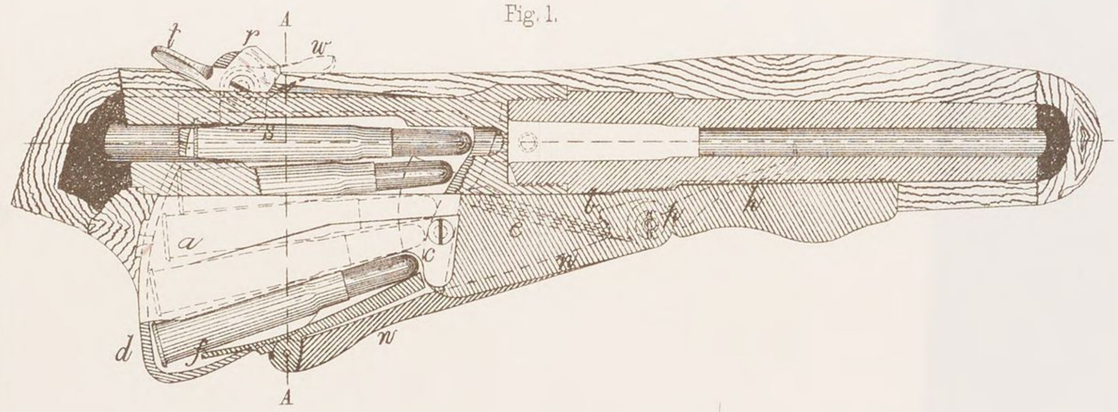


Fig. 2.

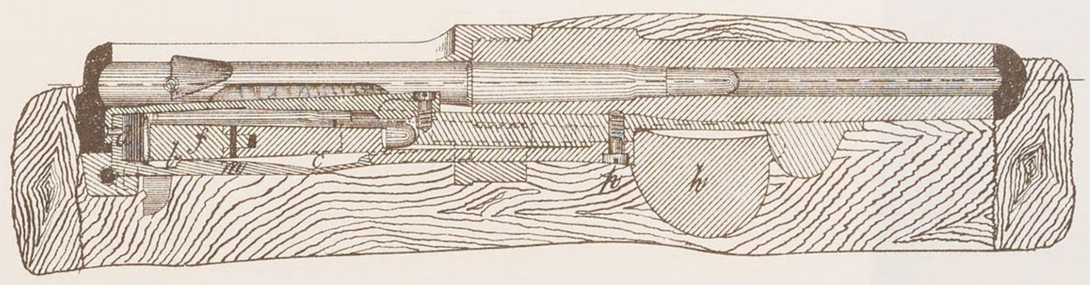
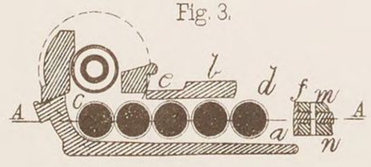


Fig. 3.



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CHAFFEE-REECE

PLATE XXIII.

Fig. 13.

Fig. 3.

Fig. 26.

Fig. 27.

Fig. 28.

Fig. 29.

Fig. 30.

Fig. 1.

Fig. 14.

Fig. 31.

Fig. 15.

Fig 16.

Fig. 17.

Fig. 24.

Fig. 25.

Fig. 2.

Fig. 23.

Fig 18.

Fig. 19.

Fig. 20.

Fig. 6.

Fig. 7.

Fig. 4.

Fig. 8.

Fig. 21.

Fig. 9.

Fig. 5.

Fig. 11.

Fig. 10.

Fig. 22.

Fig. 12.

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APPENDIX 10.

REPORT ON SIGHTS AND BAYONETS FOR SMALL ARMS.

(5 plates.)

OFFICE OF THE BOARD ON MAGAZINE ARMS,
Springfield Armory, Mass., August 15, 1892.

SIR: Some months ago, as recorder of the Board on Magazine Arms, I received your directions to prepare a report upon the sights and bayonets of the foreign arms then before the board. These directions were embodied in the following letter:

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, D. C., February 4, 1892.

SIR: You will please prepare at your earliest convenience and submit for the information of this office a report upon the sights and bayonets used upon the magazine small arms of different foreign nations.

Respectfully,

D. W. FLAGLER,
Brig. Gen., Chief of Ordnance.

The RECORDER OF THE BOARD ON MAGAZINE ARMS,
Springfield Armory, Springfield, Mass.

The work of the board has prevented the earlier preparation of the report. I have now the honor to submit

SIGHTS.

The arms treated of are the Lee-Speed, Mark I, of England; the Krag-Jörgensen, of Denmark; the Mannlicher, of Austria-Hungary; the Mauser, of Belgium; the infantry rifle, model 1888, of Germany; the Kropatschek, of Portugal, and the Schmidt, of Switzerland.

On most of these sights close adjustments of elevation are not possible, the slide engaging on the leaf or base only at certain graduation marks, no provisions being made for retaining it at other points.

None are provided with arrangement by which compensation can be made for drift or windage allowance, nor have any, for ordinary ranges, a peep or aperture sight, but only the plain open notch, either square or V-shaped.

The front sights are all strong and heavy, rather thick, with inclined, not vertical, sights. None of the sights are adapted (or in fact designed) for accurate target shooting, nor would they prove satisfactory for sharpshooters' use in action. They are, however, generally strong, serviceable, easily adjusted, and fairly well suited to the delivery of fire, using previously designated elevations.

ENGLAND.

(Pl. 1.)

In the pattern of the Lee-Speed first issued (the model before the board) the experiment was tried of substituting for the ordinary form of front sight a notch instead of the common block; it is, however, understood that in the second pattern the more usual form has been retained. This notch is in a heavy solid block sloping gradually (*a*, Fig. 1) towards the muzzle, vertical (*b*, Fig. 1) on the end next the firer. The effect of the sight is to substitute for the ordinary wedge a vertical line of light which it is intended shall be made in aiming, the continuation of a vertical white mark (*c a*, Fig. 4) on the slide of the leaf; unless aiming, however, with the principal source of light behind the soldier this latter mark can be but indistinctly seen, and the conjunction of the two lines is hardly practicable.

The rear sight consists of the base (Fig. 3; *a*, Fig. 2), of the leaf (Fig. 4; *b*, Fig. 2), and of the slide (*c*, Figs. 2 and 4). The base is attached to the barrel by two screws (*d* and *f*, Figs. 2 and 3), the first of which (*d*, Figs. 2 and 3) also secures the leaf spring (*d e*, Fig. 3) in the undercut groove in the base. On the left side of the base are the graduation marks 300 and 400. With the former, with leaf down, the slide is back near the hinge (as in Fig. 2); for the latter range the slide is slipped up the leaf on to the slightly raised forward part of the base.

In these two positions the ribs (*a*, Fig. 3) prevent twisting or bending of the leaf from a lateral blow.

The leaf is hinged to the base by a pin through its lower part (*e*, Figs. 2 and 4). It can be turned down on the base, upright, or back to the rear on the barrel; the pressure of the leaf spring (*d e*, Fig. 3) against the shoulders (*e*, *n*, and *m*, Fig. 4) retaining it as it may be adjusted. The slide (*c*, Figs. 2 and 4), from its shape (*b f*, Fig. 4), requires no additional spring to retain it at any elevation on the leaf at which it may be placed. Its ends are knurled to afford easy grasp for the fingers. The aiming notch (*c*, Fig. 4) on the slide is square, as is also that (*d*, Figs. 2 and 4) used at the end of the leaf when it is down on the base. The lowest graduation on the base and leaf is 300 yards; the highest on the leaf 1,900 yards. For greater distances the long-range sights on the left side of the stock are employed, the forward sight (Fig. 5) being placed about 3 inches in front of the base of the regular rear sight, the rear sight (Fig. 6) just above the trigger guard at the rear of the bolt. The forward sight consists of a dial (*m*, Fig. 5) graduated from 1,800 to 3,500 and of a pointer (*a e*, Fig. 5), having at its end a knob (*a*, Fig. 5) as the point over which aim is taken.

The rear long-range sight (Fig. 6) is pivoted on the arbor (*d*, Fig. 6) of the safety lock (*b*, Fig. 6) of the bolt. At the upper end of the leaf is a peep (*a*, Fig. 6). The lower end is provided with notches (*e*, Fig. 6) in which the lugs (*c*, Fig. 6) of the friction spring (*h*, Fig. 6) engage.

For all long-range firing the rear sight is in the position shown in *a m*, Fig. 6; when not in use it is shut down to *f m*, Fig. 6.

For a range of 1,800 yards the front sight is as shown at *a*, Fig. 5; for 3,500 yards, at *b*, Fig. 5; for intermediate ranges between these positions as at *c*, Fig. 5. When not in use the sight occupies the position *d*, Fig. 6.

DENMARK.

(Pl. I.)

The front sight (Fig. 1) is attached to a base (*a*, Fig. 1) forming part of a reënforce sleeve over the barrel cover (*d*, Fig. 1), and the lower part of which (*e*, Fig. 1) is used in connection with the securing of the bayonet. The distance of this cover from the axis of the barrel (*c*, Fig. 1) permits of a small sight mass. The front sight proper (*b*, Fig. 1), with its base (*a*, Fig. 1), slides into an undercut groove, the fit being made so close that small blows from a mallet are required for removal.

The rear sight consists of a base (*a*, Figs. 2 and 7), leaf (*b*, Figs. 2 and 7), and slide. The base is attached to the barrel cover by screws (*d* and *f*, Fig. 3), the former also securing the leaf spring (*d e*, Fig. 3). The heads of these screws lie within the barrel cover, below the sight. There are no graduation marks on the base.

The leaf is hinged to the base by a pin at its lower part (*e*, Figs. 2 and 4). It can be turned forward on the base or brought to a vertical position. It can not be turned back on the barrel. The leaf spring (*d e*, Fig. 3), bearing against the shoulders (*m n*, Fig. 4) at the base of the leaf, retains it either down or upright. When down aim is taken through the notch (*d*, Figs. 2 and 4) at the base of the leaf. The face of the leaf is graduated from 400 to 1,300, the back of the leaf from 1,400 to 1,900. These latter graduations are so stamped that looking at the back of the leaf from above they can be read, but looking from the muzzle of the gun directly at the back of the leaf (Fig. 6) they appear upside down. On the left edge of the leaf (*p*, Figs. 4, 5, and 6) are notches in which the catch (*a*, Fig. 4) of the slide engages. The slide (*d f*, Fig. 4) fits over the sides of the leaf. To retain it at a desired elevation a catch (*a*, Fig. 4), actuated by a spring (*c*, Fig. 4), is provided. Pressing on the knurled base (*b*, Fig. 4) of the catch and at the same time grasping the slide at the opposite end (*d*, Fig. 4) it can be moved along the leaf. Unless the catch is in one of the notches (*p*, Fig. 4) the slide easily slips, and as these correspond only to the even 100 in elevation no closer adjustments are provided for.

For ranges up to 1,300 the face of the leaf, the notch *f*, Fig. 4, and the ordinary front sight (Fig. 1) are used. For greater distances the notch on the right end of the slide (*d*, Figs. 4 and 5) with the graduations on the back of the leaf (Fig. 6) make the rear sight, and a knob (*b*, Fig. 9) on the right-hand side of the upper band constitutes the front sight.

AUSTRIA-HUNGARY.

(Pl. I.)

The front sight proper (*b*, Fig. 1) is secured to the sight mass (*a*, Fig. 1) in the same manner as in the Danish gun. The sight mass itself is welded to the barrel, there being no separate barrel cover to the arm.

The rear sight is composed of the base (Fig. 7; *a*, Figs. 2 and 5) and the leaf (*b*, Figs. 2 and 5) with its spring (*a*, Figs. 4 and 6) and the two adjusting arms (*c*, Figs. 4 and 6). The base is made solidly with the barrel and can not be removed; on either side its faces (*a*, Figs. 2, 5, and 7) rise, smooth on their outer surfaces (*a*, Figs. 2 and 5), notched on the rear portion of their inner surfaces (*c*, Figs. 2 and 7). The top faces of these sides are graduated, the left hand from 500 to 1,700 meters, the right hand from 1,800 to 2,500 meters.

The leaf (*b*, Figs. 2, 4, and 5) is hinged (*e*, Figs. 2 and 5) to the front end of the base, the sighting notch (*d*, Figs. 2 and 5) being in the end of the leaf nearer the firer. Pivoted (*f*, Fig. 6) to the under side of the leaf are two arms (*c c*, Figs. 4 and 6), which by a spring (*a*, Figs. 4 and 6) are held out into the notches (*c*, Figs. 2 and 7) on the inside of the faces of the base, thus retaining the leaf at the elevation desired. Pinching together these arms by pressure on their knurled ends (*m*, Figs. 4 and 5) the sides of the arms will be drawn out of the notches and movement of the leaf permitted. The sight notch on the leaf (*d*, Fig. 2), the front sight (*b*, Fig. 1), and the graduations on the left face of the base (*m*, Figs. 3 and 8) are used for distances up to 1,700 meters. On the lower side of the end (*d*, Fig. 5) of the leaf is a slide, operated by a thumb piece (*c*, Figs. 3, 5, and 8), motion being controlled by a friction screw (*f*, Fig. 3). When this slide is pulled out to the right, a notch (*d*, Fig. 8) in its upper edge forms the rear sight for use with the graduations on the right face (*n*, Figs. 3 and 8) of the base for distances from 1,800 to 2,500 meters. The front sight for these longer ranges is a pin (*b*, Figs. 9 and 10) on the right-hand side of the middle band. This pin fits in a socket (*c*, Fig. 9), forming part of the band, and is there secured by a screw (*d*, Fig. 9) passing completely through the stock. When the leaf is entirely down on the base the sight is adjusted for a little under 400 meters.

Slight adjustments of the sight can not be made, the leaf being held only when in the notches already mentioned, which are for increments of 100 meters in the distance.

BELGIUM.

(Pl. II.)

The front sight (*b*, Fig. 1) is attached to a small sight mass (*a*, Fig. 1), forming part of a sleeve over the barrel cover (*d*, Fig. 1), which also carries, as in the Danish gun, the attachment (*e*, Fig. 1) for the bayonet.

The rear sight on the arm obtained from the Belgium Government is very similar to the pattern on the Springfield rifle before the adoption of the model 1884 (Buffington sight) now in service. It consists of a base (*a*, Figs. 2 and 3), a leaf (*b*, Figs. 2 and 4), with its spring (*d e*, Fig. 3), and a slide (*b f*, Fig. 4).

The faces of the base are stepped and marked with the graduations 100, 200, 300, and 400. For these ranges the slide is slipped forward, resting on these steps along the leaf, and aim taken through the notch (*d*, Fig. 2) at the end of the leaf. The leaf is hinged (*e*, Figs. 2, 3, and 4) to the rear of the base; it is held erect by the bearing of the leaf spring (*e*, Fig. 5) upon the surface (*n*, Fig. 4) at the base of the leaf. The faces of the two sides of the leaf are graduated, the left for the odd-numbered distances from 500 to 1,500, the right for those from 600 to 1,400. The slide, from its peculiar shape (*b f*, Fig. 4), requires no separate spring or notches to retain it at any adjusted position on the leaf; its ends are knurled (*a d*, Fig. 4) to prevent slipping when grasped by the fingers. Its sight notch (*c*, Fig. 4) is V-shaped.

GERMANY.

(Pl. II.)

The front sight (*b*, Fig. 1) is attached to the sight mass (*a*, Fig. 1), as in the Danish and Belgian guns; the sight mass itself forming part of the barrel cover (*d*, Fig. 1). The rear sight consists of the base (*a*, Figs. 2 and

5), the leaf (*b*, Figs. 2, 3, and 7), with its spring (Fig. 4), and the slide (*c*, Figs. 3 and 7) with its catch (*h a*, Fig. 3). The base is without graduation and merely serves to contain the leaf spring and the journals (*e*, Fig. 5) for the leaf hinge. The leaf, hinged (*e*, Figs. 3, 5, and 7) to the base, is graduated on the faces of its right and left arms, the former with the even and the latter with the odd numbered distances from 500 to 1,800. At the top of the leaf (*d*, Fig. 7) is a sight notch for a range of 2,050 meters. The right side of the right-hand arm of the leaf is notched (*m*, Figs. 3, 6, and 7); in these notches the catch (*a*, Fig. 3) of the slide engages, retaining the slide at the desired elevation. The slide fits (*m* and *n*, Fig. 3) over the arms of the leaf. To the right is a slot for the catch (*a*, Fig. 3), which is there secured by a pin (*d*, Fig. 3) acting as a pivot. Pressure on the thumb piece (*c*, Figs. 6 and 7; *h*, Fig. 3) lifts the catch from the notches and permits movement of the slide along the leaf. The left edge of the slide (*s*, Figs. 3 and 7) is roughened to give the fingers a more secure hold. The leaf, raised, is shown in Figs. 6 and 7, the former being a side, the latter a face view; pressure of the spring (*e*, Fig. 4) upon the base of the leaf, retains it in either the vertical (Fig. 7) or lowered (Fig. 2) positions.

The leaf can not be turned back upon the barrel. Intermediate adjustments of the sight for small differences in elevation can not be made.

PORTUGAL.

(Pl. II.)

The front sight proper (*b*, Fig. 1) is secured to the sight mass (*a*, Fig. 1) in the same manner as with the arms previously mentioned. In the gun before the board the assembling marks are so placed that the sight is thrown over to the left of the vertical plane through the axis of the bore. The barrel being rifled from right to left, this method of placing the front sight would correct for the drift at some one particular range, but not, with accuracy, at any other distance.

The rear sight consists of the base (*a*, Figs. 2 and 7), which is formed as part of the barrel; the leaf proper (Fig. 4; *s*, Figs. 2 and 8), with its spring (Fig. 6) engaging in a slot (*d*, Fig. 7) in the base; and the slide leaf (Fig. 5; *b*, Figs. 2 and 8) with its attachment (*m n*, Fig. 5) to the leaf. The leaf is hinged (*e*, Figs. 2, 4, and 7) to the front end of the base and can be turned either forward or back on the barrel, or vertically; the pressure of the spring on the surfaces at the bottom of the leaf (*m*, *e*, and *n*, Fig. 4) retaining it in whichever position it is placed.

Both arms of the leaf are graduated, the left (*s*, Fig. 8) from 500 to 1,500, and the right (*d*, Fig. 8) from 1,700 to 2,200; the intermediate 50 metric graduations are also indicated. For the first-mentioned distances aim is taken through the notch (*c*, Figs. 3, 5, and 8) in the cross bar of the slide; for 1,600 meters, through the notch (*a*, Figs. 4 and 8) at the top of the leaf, and for the longer distances through the notch (*m*, Figs. 3, 5, and 8) at the top of the slide leaf. The slide leaf is connected with the leaf proper by a cross bar (*m n*, Fig. 5) having grooves engaging over the arms of the leaf; screws (*n*, Figs. 3 and 8) limit the upward travel of this bar. In one piece with the cross bar is the upper portion (*b*, Figs. 2 and 8) of the slide; its arms (*b*, Fig. 3) traversing channels left in a separate piece (*p*, Figs. 3 and 8) joined to the leaf proper by the screws (*n*, Figs. 3 and 8) before mentioned.

The fit of the crossbar (*m n*, Fig. 5) and of the slide in the channels

(*b*, Fig. 3) is so close that the slide leaf will remain in any position that it may be set; it is therefore possible to make closer adjustments in the elevation than indicated by the intervals in graduation.

SWITZERLAND.

The front sight on this arm is attached, in the manner described for the other foreign arms, to a sight mass which surrounds the barrel in the form of a collar just forward of the wooden barrel cover.

The rear sight is very similar to that on the Austrian Mannlicher (Pl. 1), except that there is no separate long range sight, the faces (*a*, Fig. 2) of the base being higher and the graduation, which is on the upper edge of the left face, extending from 400 to 2,000 meters; these graduations are marked with notches on the inner surface (*c*, Fig. 7) of the face. The leaf is hinged at the front of the base; it has two arms, the right moving against the right side of the base; the left, in the form of a spring, engages in a slot in the right arm and moves with it and it also engages in the notches (*c*, Fig. 7) before mentioned. The leaf down on the base is fixed for a range of 300 meters. Small adjustments in elevation can not be made.

BAYONETS.

Examining the bayonets of the foreign arms before the board, it is at once observed that the old form of triangular bayonet, with socket clasping the barrel, has been universally replaced by a knife bayonet, the forms varying somewhat for the different guns, but yet being very similar.

The blades of these knives are from $9\frac{3}{4}$ to 12 inches long and about 1 inch in width. The knives all have short guards, generally straight, and handles of wood and steel, about 4 inches in length; the weights vary between $8\frac{1}{2}$ and $15\frac{1}{2}$ ounces.

The bayonets described below are those of England, Denmark, Austria, Belgium, Japan, and Switzerland. The other foreign guns before the board were received without bayonets, but from the attachments on their barrels, or from such published descriptions as were available, it was evident that all used the knife bayonet in forms very like those mentioned.

ENGLAND.

(Pl. III.)

The blade (*b*, Fig. 1) is 12 inches long and $1\frac{1}{16}$ inches in extreme width; it is double-edged (*b* and *c*, Fig. 1) with a slightly raised rib between. There is a short guard (*m n*, Figs. 1 and 2), of which one end (*m*, Figs. 1 and 2) is made in the shape of a ring to encircle the barrel. The handle is partly of wood (*e*, Figs. 1 and 5) and partly of steel, the tang of the knife (*b*, Fig. 5) passing between the wooden sides into a cut in the latter part. The lower end of the tang is forked, making a groove (*a*, Fig. 1) for the reception of the head of the cleaning rod (*d*, Fig. 1) when the bayonet is fixed. The stock is terminated by a metal tip (*f*, Figs. 1 and 3), the bayonet when fixed resting on the flat plate (*f*, Fig. 3) forming its upper surface. Projecting from this plate is a rib (*s*, Figs. 1 and 3) which enters the channel (*s a*, Fig. 1) in the bottom of the bayonet and has a notch (*a*, Fig. 3) over which the

hook (*c*, Figs. 2 and 5) of the spring clasp of the bayonet engages. This clasp is freed by pressure on the thumb piece (*a*, Figs. 2 and 5). The bayonet can be fixed, without touching the clasp, by simply putting it smartly into the position shown in Fig. 1.

The scabbard (Figs. 4, 6, and 7) is of leather, tipped with metal; the bayonet is retained in the scabbard by the springs (*a*, Fig. 4). The weight of the bayonet is $15\frac{1}{5}$ ounces; of the scabbard, 5 ounces.

DENMARK.

(Pl. III.)

The length of the knife blade is but 9 inches, but as part of the handle (Fig. 1) projects beyond the muzzle, the bayonet becomes about $10\frac{1}{2}$ inches long. The knife has but one edge (*a*, Fig. 1), with a strong back (*b*, Figs. 1 and 3). Handle and blade are in one piece, recesses being made in the two faces of the handle for the wooden grips (*c*, Figs. 1, 2, and 3). On the lower part of the back of the handle is an under-cut channel (*d*, Fig. 3), through which slides the corresponding rib (*d*, Figs. 1 and 2) on the under side of the barrel cover, the knife being pushed down until the hook (*e*, Fig. 1) of the clasp (*m*, Figs. 1, 3, and 4) engages over the shoulder (*e*, Fig. 1) of the rib. The clasp, with its spring (*n*, Figs. 1 and 4), is placed in a socket in the handle of the knife and is operated by a lever (*p*, Figs. 1 and 4), pivoted to the handle (*f*, Figs. 1 and 4). Raising the thumb piece (*p*, Fig. 1), the short arm (*m*, Fig. 1) of the lever lowers the clasp, compressing its spring (*n*, Fig. 1), and permits the knife to be withdrawn.

The scabbard (Figs. 5 and 6) is of leather, tipped with metal. It retains the bayonet by means of a spring (*a*, Figs. 5 and 6), which is secured in the mouth piece by a screw (*c*, Fig. 6). The weight of the bayonet is $8\frac{1}{2}$ ounces; of the scabbard, 3 ounces.

AUSTRIA.

(Pl. IV.)

The length of the blade is $9\frac{3}{4}$ inches; its extreme width, 1 inch. It has but one edge (*a*, Fig. 1); the back (*b*, Fig. 1) is strongly ribbed. The guard (*c d*, Figs. 1 and 3, which is section on A A, Fig. 1) extends but one-fourth inch below the edge of the blade, but at the other end is formed into a band (*d e*, Figs. 1 and 3), which encircles the muzzle of the barrel. Unlike all the other bayonets described in this report, the Austrian is not attached below the barrel, but to the left side of the stock, the rib (*d*, Figs. 1 and 4) for that purpose being on the upper (or tip) band (*m*, Figs. 1 and 4), which is securely attached to the stock by a screw (*n*, Figs. 1 and 4).

The tang (*m*, Fig. 2) is welded into a socket in the metal end (*m*, Fig. 1) of the handle; leaving, back of the guard, recesses for the wooden side pieces (*f*, Figs. 1, 2, and 3) of the grip. The clasp (Fig. 5) is very similar to that on the English bayonet, the hook (*p*, Fig. 5) engaging below the shoulder (*p*, Fig. 1) on the band. Pushing in the thumb piece (*h*, Figs. 1, 4, and 5) compresses the spring (*c*, Figs. 4 and 5), frees the hook, and permits the knife to be removed from the gun.

The scabbard (Figs. 6 and 7) is entirely of metal; the bayonet is retained by springs (*a*, Fig. 7), which form part of the interior mouth piece.

The weight of the bayonet is 13 ounces; of the scabbard, $6\frac{1}{4}$ ounces.

BELGIUM.

(Pl. IV.)

The length, width, thickness, and shape of the blade are almost exactly the same as in the Austrian bayonet. The guard is considerably longer, one end (*s*, Figs. 1 and 3) clasping the barrel in front of the barrel cover, the other (*b*, Figs. 1 and 3) curving up toward the edge of the blade.

Sections AA, BB, etc., as indicated in Fig. 1, show the construction of the handle of the knife.

The attachment rib (*d*, Figs. 1 and 3) is similar to the Austrian, and, like it, is on the upper (tip) band. It is below the barrel, however, instead of on the side; the clasp (Fig. 4; *e*, Figs. 1 and 2) is almost identically the same as the Austrian.

The scabbard (Figs. 5 and 6) is entirely of metal; the springs (*a*, Fig. 6) form part of the interior mouth piece.

The weight of the bayonet is $15\frac{1}{2}$ ounces; of the scabbard, $4\frac{1}{4}$ ounces.

JAPAN.

(Pl. V.)

The blade of the knife is 11 inches long, but only seven-eighths of an inch in width. It has but one edge. The guard is similar in shape to that of the Belgian knife. It however is not engaged over the barrel, but over the band (*m*, Fig. 1), which closes the upper end of the tubular magazine of the gun. A notch (*a*, Fig. 2) fits over a rib at the end of the tip, to give additional security. On the under side of the band is the large rib (*d*, Figs. 1 and 5) over which the groove (*d*, Fig. 4) in the back of the handle slides.

The handle, which is quite short, is of metal, with two short wooded sides (*a*, Fig. 4) between the guard and the portion carrying the clasp; the tang is secured by pins (*c*, Figs. 1 and 4) to the latter part.

The clasp (Fig. 6; *e*, Figs. 1 and 4) differs but little in construction, and none whatever in operation, from those on the Austrian and Belgian knives.

The scabbard (Figs. 7 and 8) is of metal; the interior mouth piece (Fig. 9) terminates in springs which retain the bayonet. It is fastened into the scabbard by a screw (*a*, Fig. 8).

The weight of the knife is $10\frac{1}{2}$ ounces; of the scabbard, $4\frac{1}{4}$ ounces.

SWITZERLAND.

(Pl. V.)

The blade is $11\frac{3}{4}$ inches long and a little over an inch in extreme width. Through most of its length it has but one edge, but from a point (*c*, Fig. 1) about 4 inches from the point a second edge is made by sloping off the back (*b*, Fig. 1).

The guard is straight, nearly 4 inches long, and projects about equally from the edge and the back of the blade; it engages over the barrel (*d*, Figs. 1 and 3), just below the muzzle.

The lower attachment for the knife is the usual rib (*e*, Figs. 1 and 3) on the upper band, which on this arm incloses the two sections of the wooden barrel cover (Fig. 3).

The handle is terminated by the metal end (*m*, Fig. 1) containing the groove (*d*, Fig. 2) into which the rib on the band slides.

The handle has wooden side pieces (*f*, Figs. 1 and 2) and is so shaped as to afford a firm grip for the hand.

The clasp (Fig. 4; *m*, Figs. 1 and 2) is practically the same as on the Belgian arm.

The scabbard (Figs. 5 and 6) is entirely of metal. It has a mouth piece with springs (Fig. 7), secured by a screw (*a*, Fig. 6).

There is no hook for attachment to the waist belt, as on all the other scabbards previously mentioned, but instead a strip of leather (*b*, Fig. 6) about 3 inches long is secured to a fixed ring near the mouth piece.

The weight of the knife is 15½ ounces; of the scabbard, 4 ounces.

From the length and stiffness of the partly double-edged blade the Swiss knife is fully as good a bayonet as any of the others described. As a knife, used as a weapon, its double guard and the shape of the handle give it an advantage over the others used.

For cutting brush or for breaking up when held in the hand the surface of the ground, it is also thought to be their superior, in consequence of the better balance and better cross-section of its blade.

It has also one of the best forms of attachment to the rifle.

Very respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord. Dept., U. S. Army, Recorder.

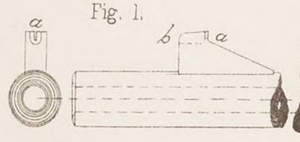
The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

(4476–'92.)

LEE-SPEED.

(ENGLAND.)

Fig. 1.



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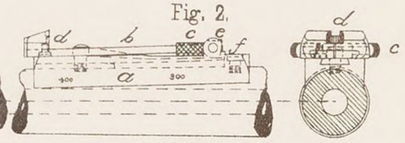

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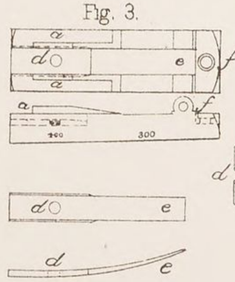

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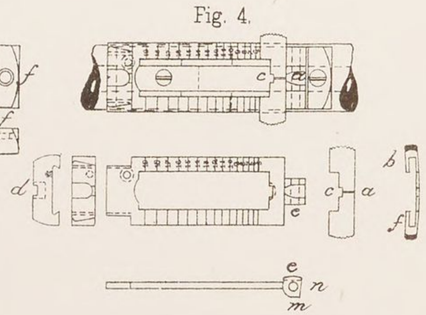


Fig. 5.

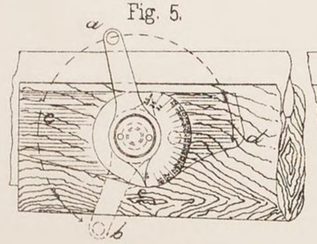
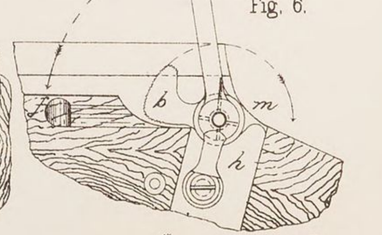
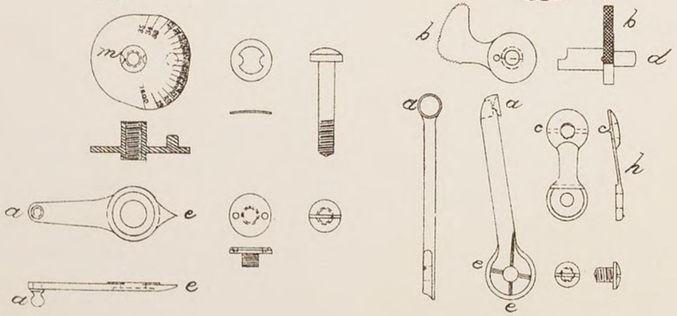


Fig. 6.

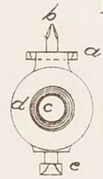




KRAG-JORGENSEN.

(DENMARK.)

Fig. 1.



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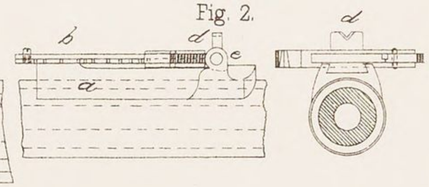

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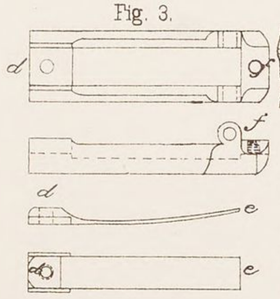

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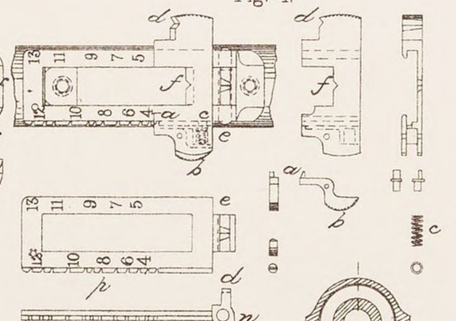

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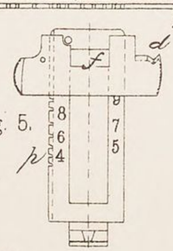

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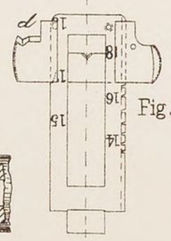

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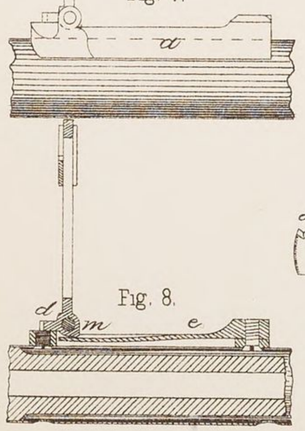

Fig. 8.

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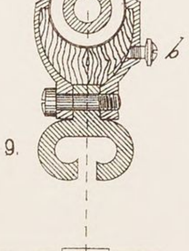

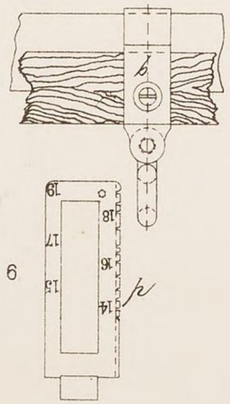

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(AUSTRIA.)

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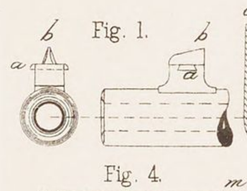

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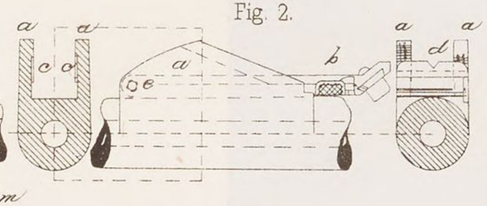

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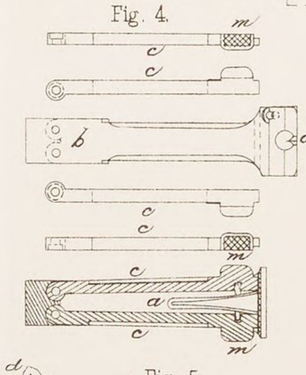

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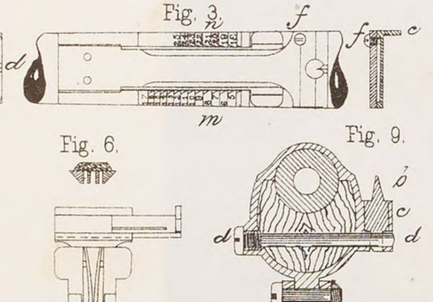

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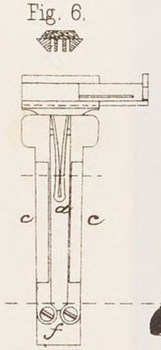

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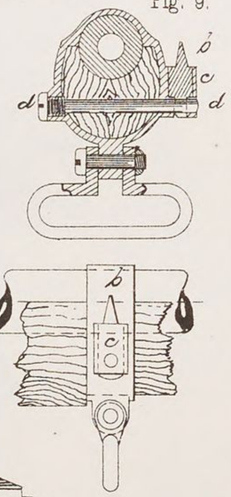

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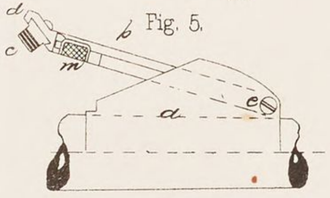

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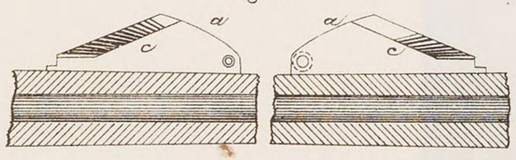

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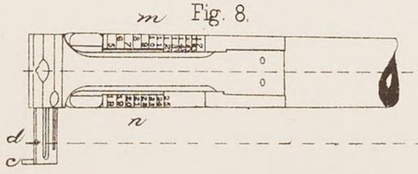

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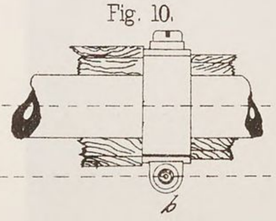

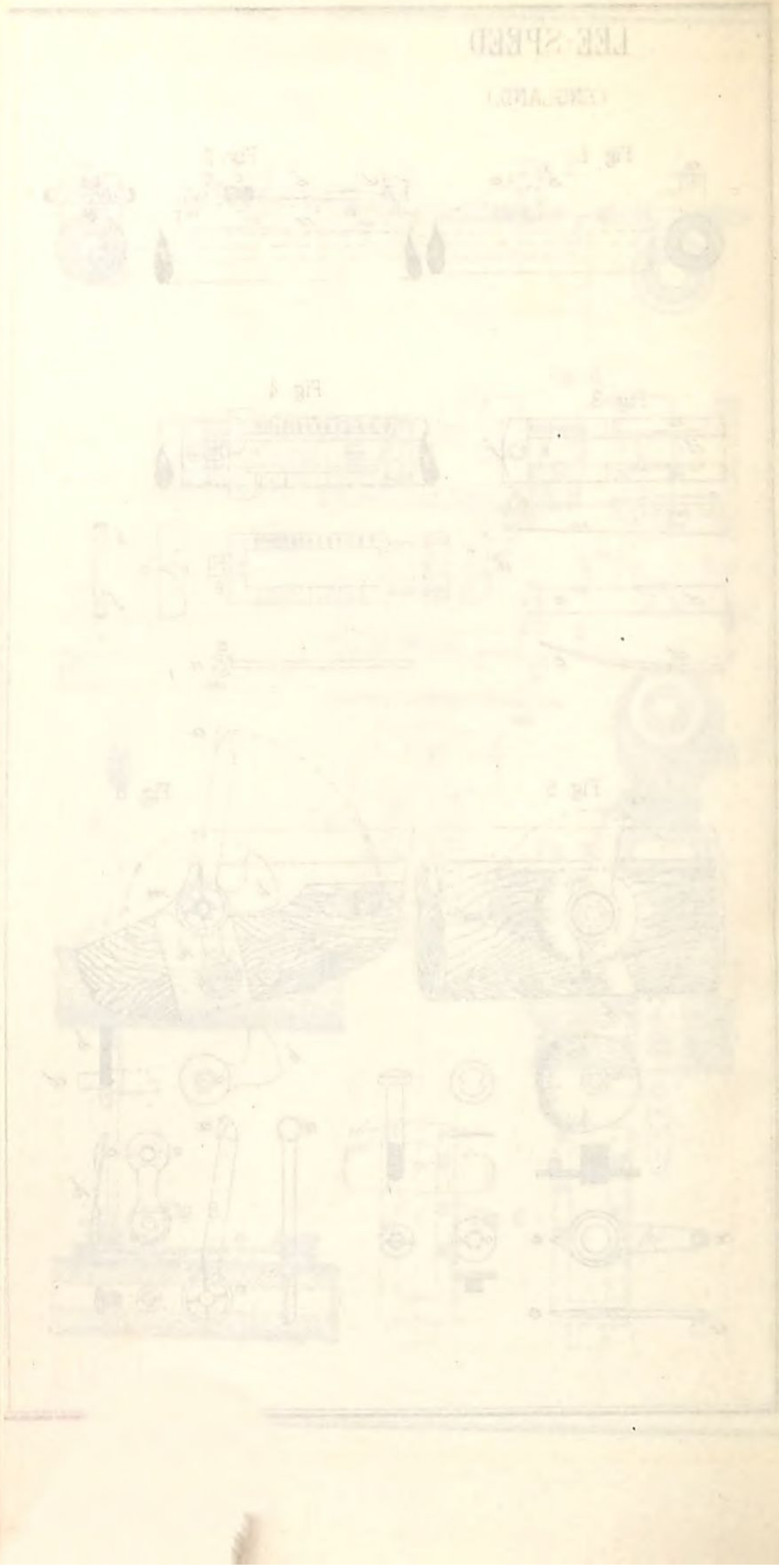

MAUSER.

(BELGIUM.)

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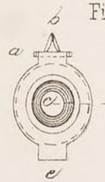

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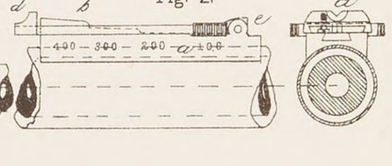

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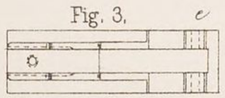

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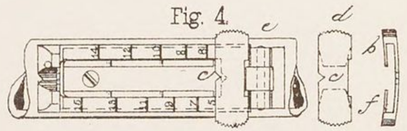

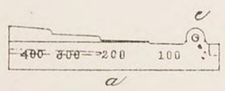

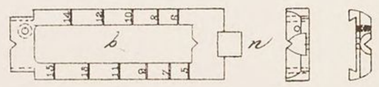

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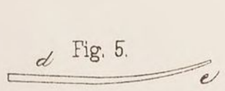
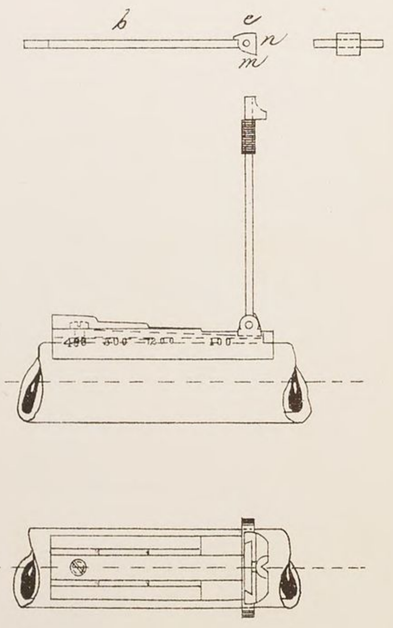
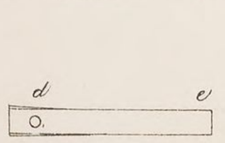
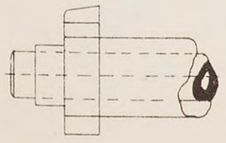
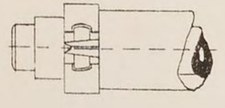






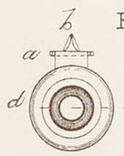




INFANTRY RIFLE.

(GERMANY.)

Fig. 1.



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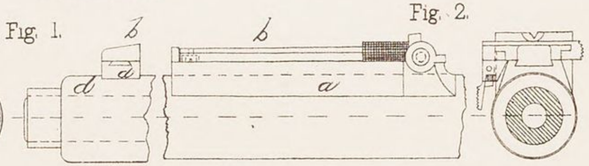

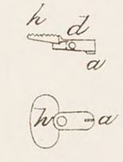

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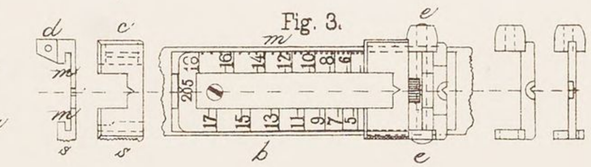

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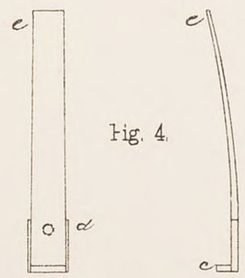

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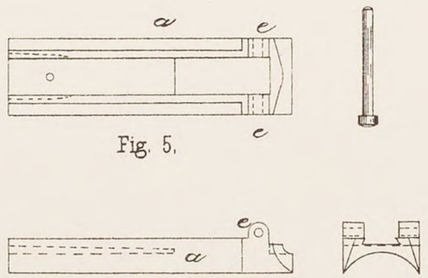

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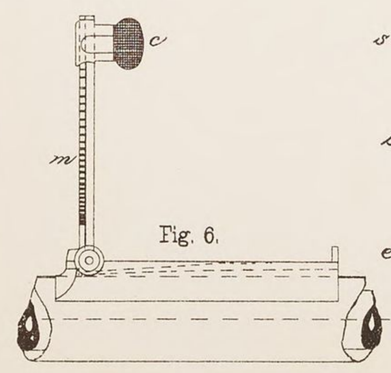

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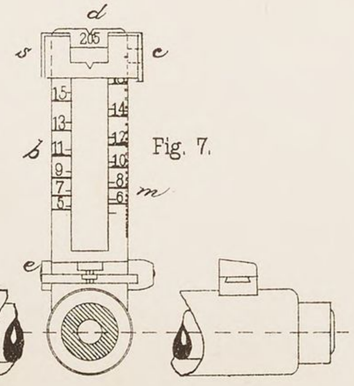
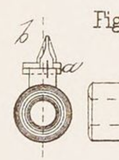


KROPATSCHEK.

(PORTUGAL.)

Fig. 1.



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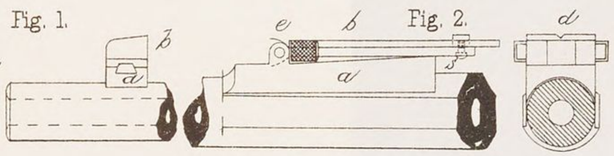

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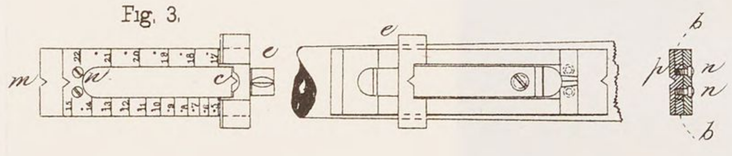

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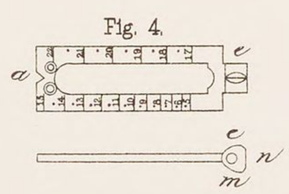

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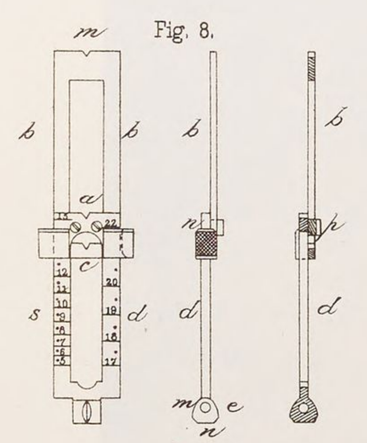

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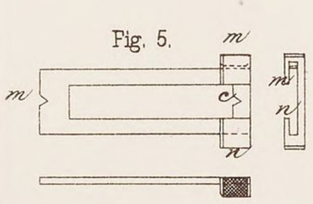

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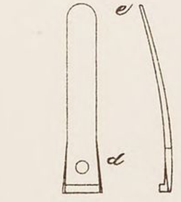

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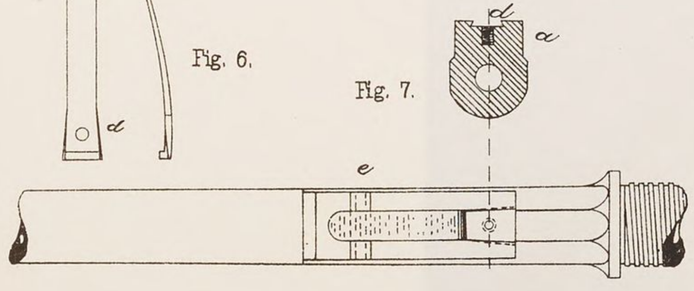

Appendix 10, 1892.

LEE-SPEED.

(ENGLAND.)

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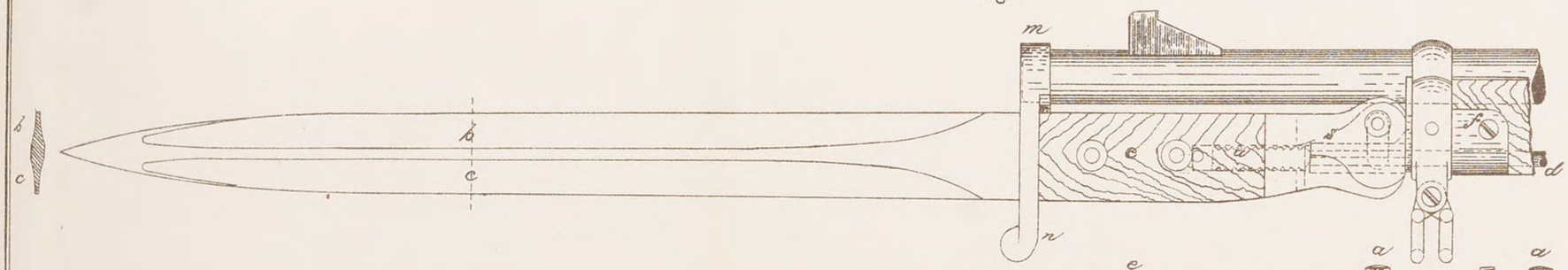

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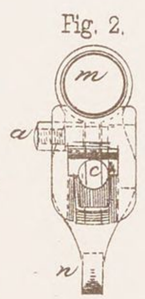

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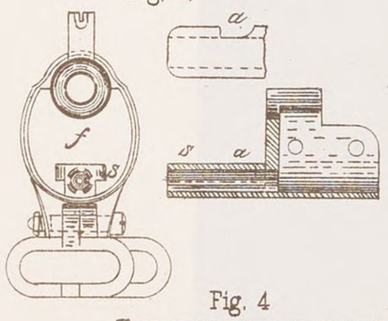

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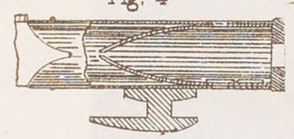

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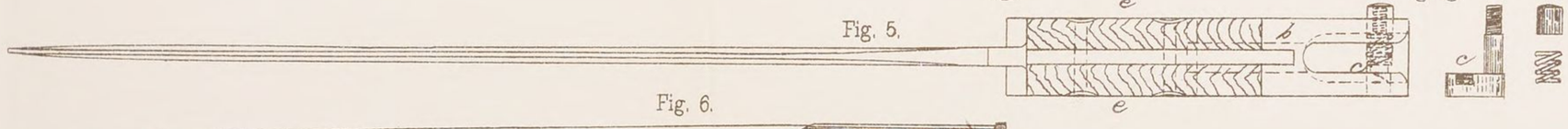

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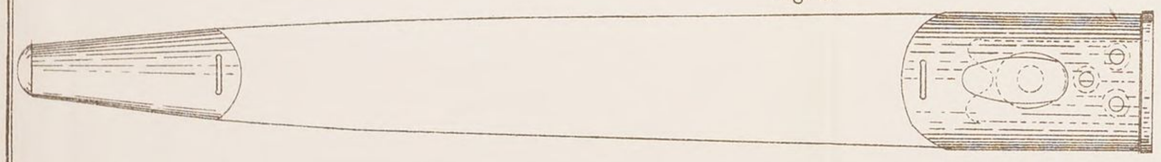

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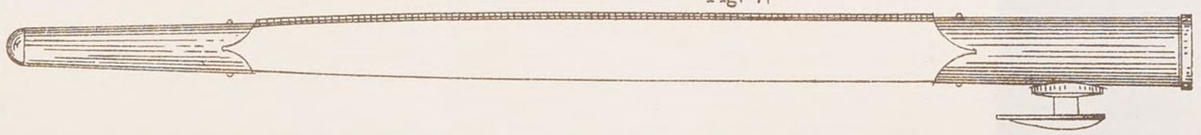
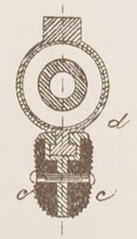


KRAG-JORGENSEN.

(DENMARK.)

Fig. 2.



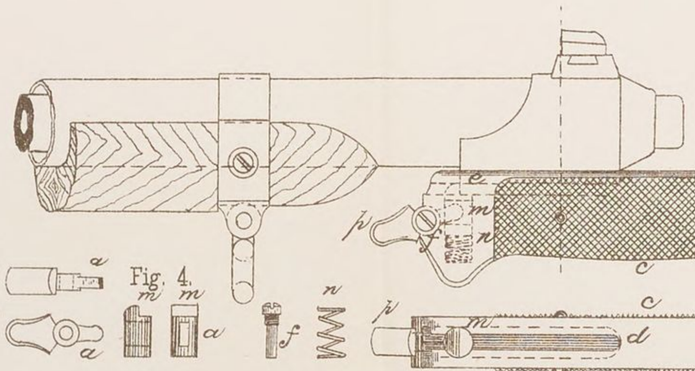


Fig. 4.

Fig. 1.

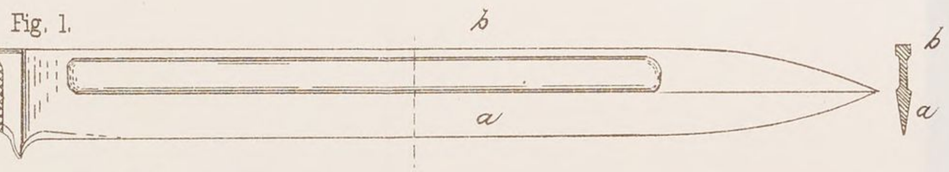


Fig. 3.

Fig. 5.

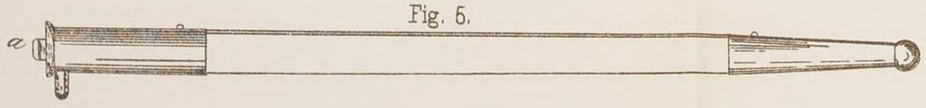
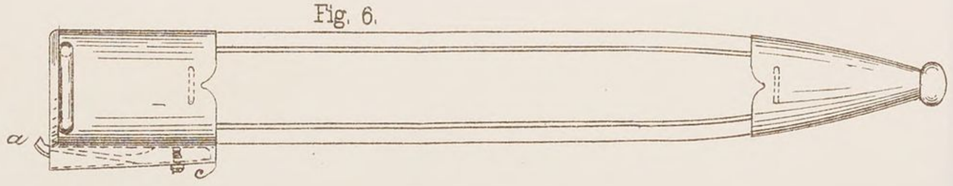


Fig. 6.



LEE-SPEED.

(ENGLAND.)

KRAG-JORGENSEN.

(DENMARK.)

MANNLICHER.

(AUSTRIA.)

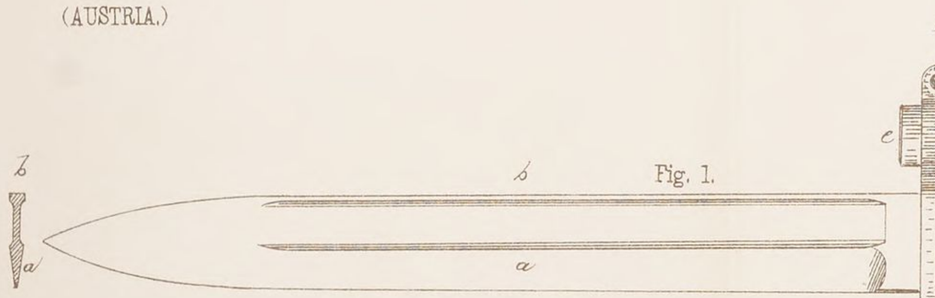
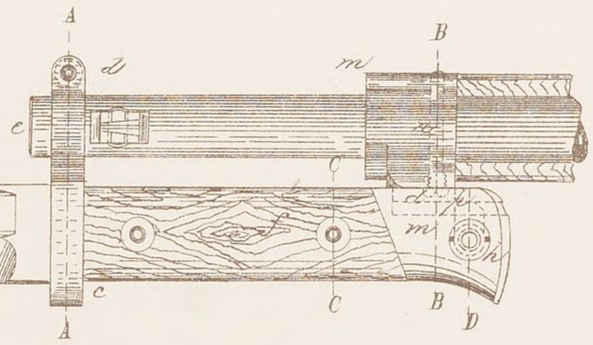
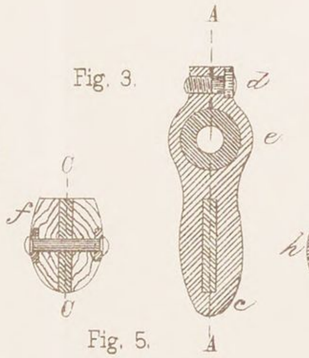


Fig. 1.





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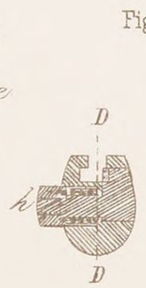


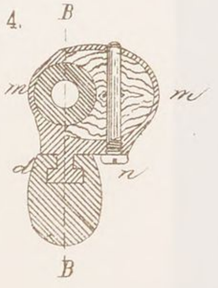


Fig. 4.

Fig. 5.

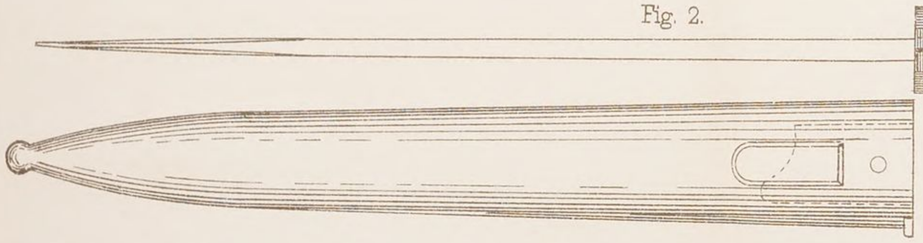
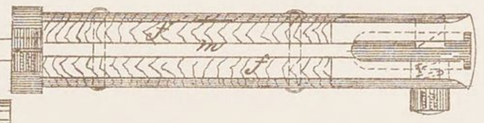
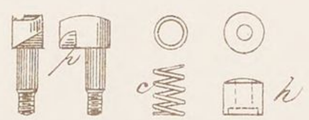


Fig. 2.





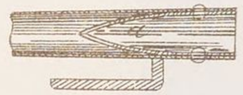
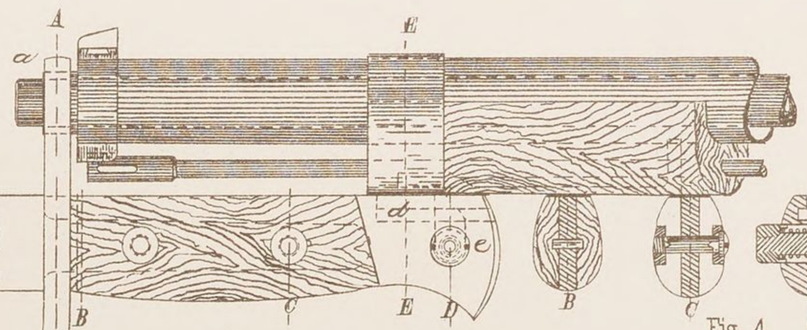


Fig. 6.

Fig. 7.

MAUSER.

(BELGIUM.)



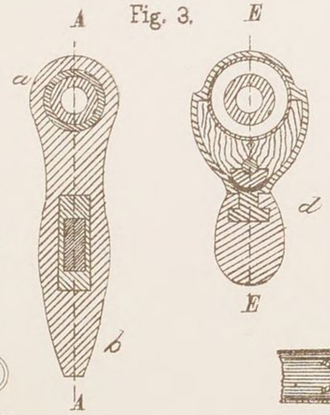


Fig. 3.

Fig. 1.

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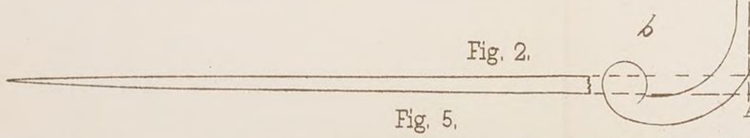


Fig. 4.

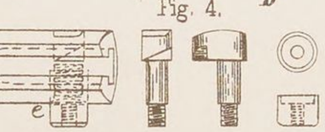
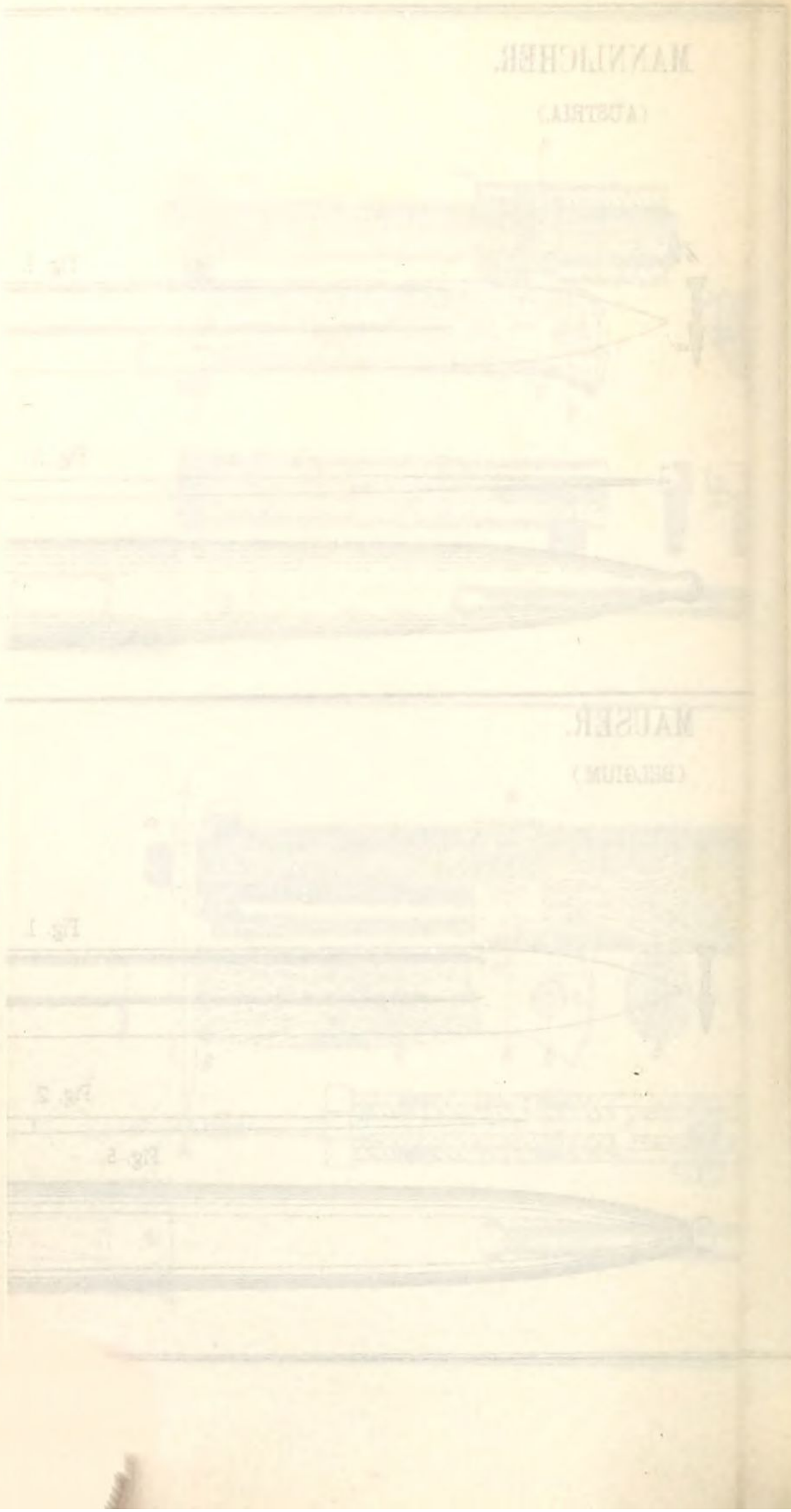


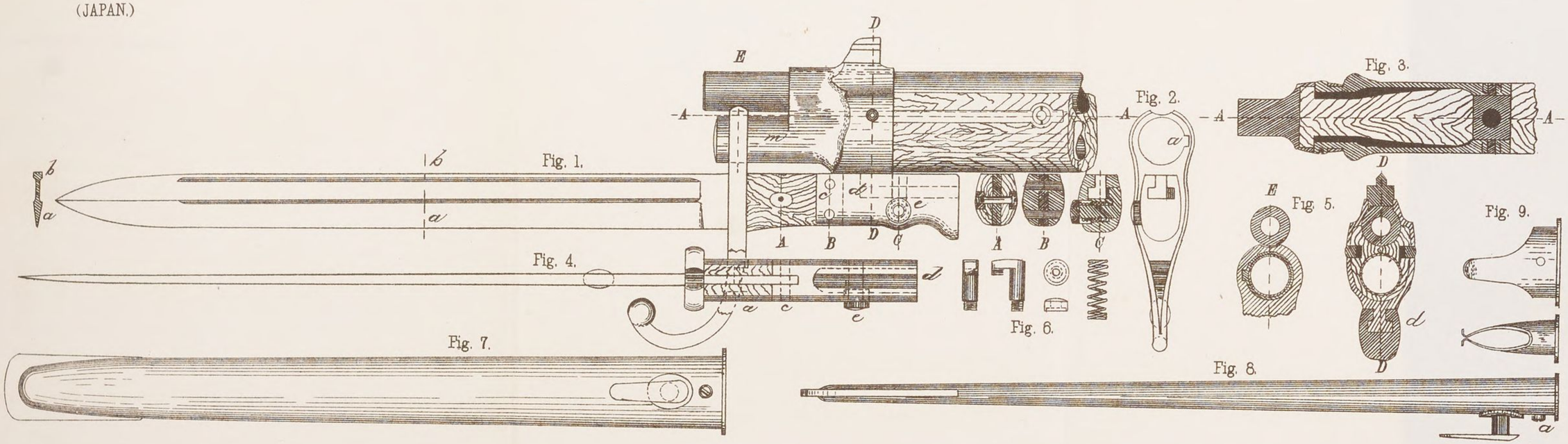
Fig. 5,

Fig. 6,



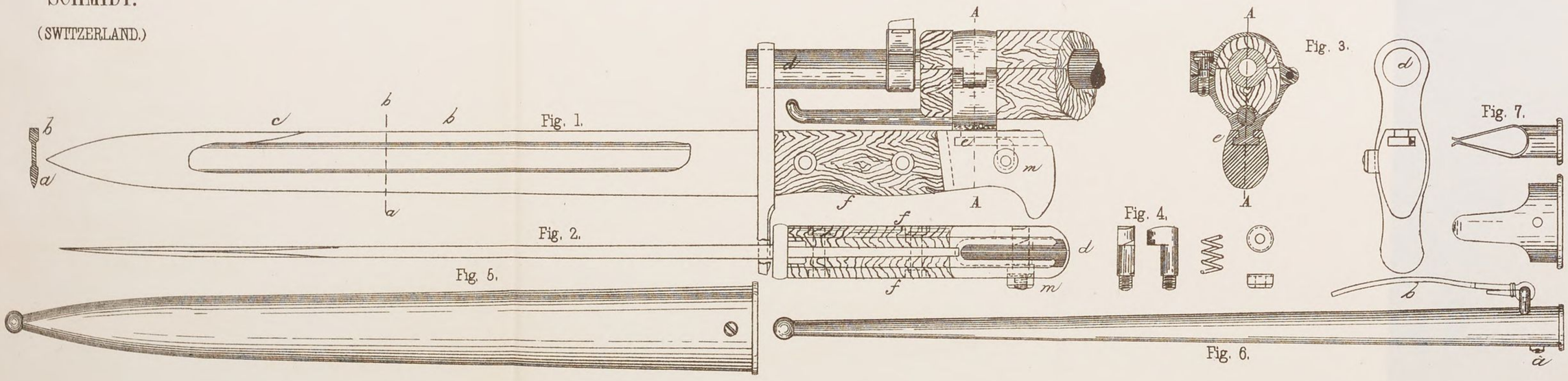
MURATA.

(JAPAN.)



SCHMIDT.

(SWITZERLAND.)



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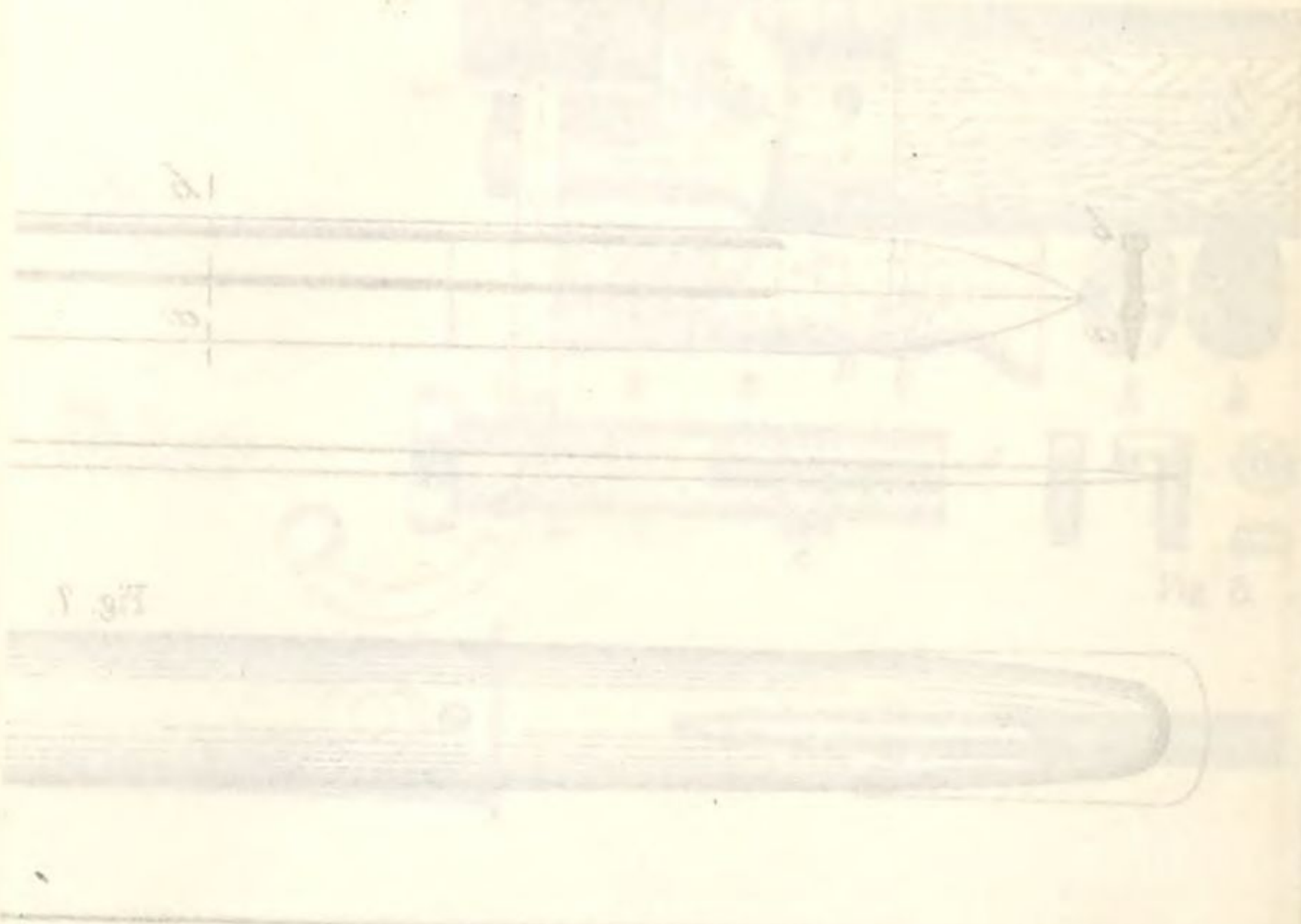

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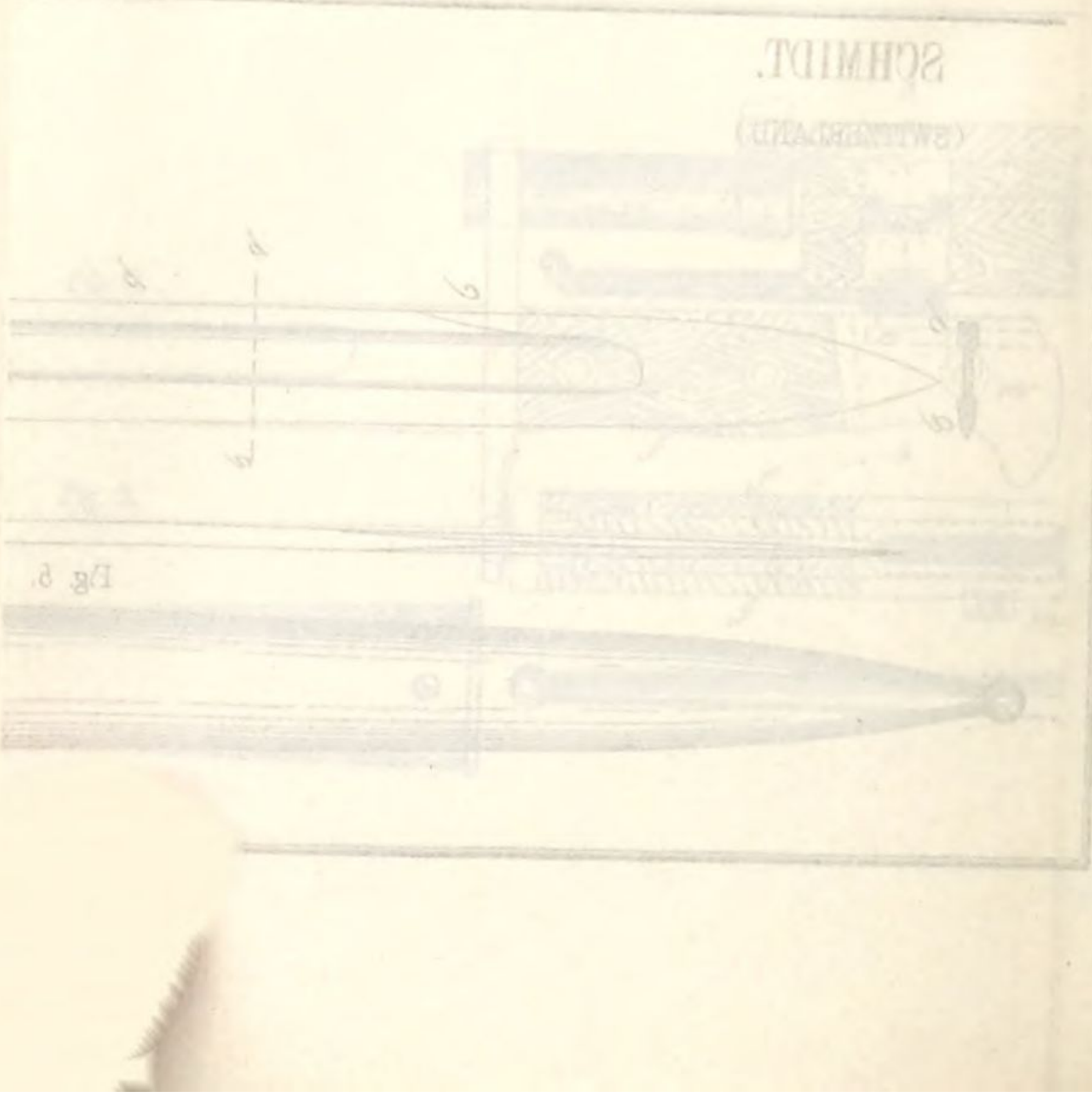


APPENDIX 11.

REPORT OF THE PRINCIPAL OPERATIONS AT THE COLUMBIA ARSENAL, COLUMBIA, TENN., DURING THE FISCAL YEAR ENDED JUNE 30, 1892.

BUILDINGS.

Since my last report the following buildings have been completed under the contract made with Frank Goodwin, approved by the Chief of Ordnance, U. S. Army, January 24, 1890, viz: Commanding officer's quarters, September 12, 1891; main storehouse, December 19, 1891.

SEWERAGE.

The sewerage system has been completed in accordance with the following specifications, approved by the Chief of Ordnance, February 3, 1890, viz:

In the order of importance this work stands next to the construction of the buildings, and should be undertaken before their completion. A part of the excavation for trenches will be through rock that will require blasting. Work of this character in all trenches near buildings should be completed before the laying of the foundations, so as to avoid danger of injury to the walls by powder shakes.

The natural formation of the grounds is such that drainage of all kinds from the arsenal must find an outlet in Little Bigby Creek. In order to reach this stream it will be necessary to secure the right of way over the property of adjoining landholders. All of the landholders have assured me they have no objection to the main sewer being laid on their property. I have addressed a letter to each individual, asking his written consent thereto, and I anticipate no trouble in this direction. If an outlet is not secured in Little Bigby Creek for the main sewer, it will be necessary to rely upon cesspools, the overflow from which must find an outlet in this stream. This would be found very unsatisfactory and, in the end, more costly than a well-devised system of sewers.

Sanitary engineers recognize two systems of sewerage, known as the separate system and the combined system. The object of the separate system is to carry off the sewage proper from the interior of buildings. The combined system is designed to carry the storm water and sewage. In small cities, where there is not a dense population, the tendency, on account of economy in construction and cost of keeping in repair, is to make use of the separate system, the storm water being carried off by gutters, or open drains, discharging into large or small streams that may be available, or else allowed to distribute itself over the surface of the ground, thus admitting the use of sewer pipes of small diameter, which are much less expensive than those of large diameter.

In the particular case under consideration, owing to the very favorable location of all the buildings for which sewage is to be provided, the sites being on the crests of hills which slope rapidly toward the valley in which is located the main pipes of sufficient diameter to carry of all storm water, in addition to the waste and liquid refuse, can be used without sensibly increasing the cost of the system of sewerage. The combined system is therefore recommended.

In designing sewers of this kind, the grade being established, the size of the pipe to be used should be determined by the maximum amount of rainfall per hour, minute, or second during storms likely to occur with more or less frequency, and the sewage proper.

For any considerable portion of time, say for one year, the sewage proper may exceed in amount the total rainfall for that period; but the volume of rain water to be provided for during storms is so much greater than the sewage (the proportion in cities being about 40 to 1) that the amount of sewage scarcely enters into the computation.

In determining the diameter of the pipes to be used in the main and all of the laterals, the maximum rainfall during severe local storms has been taken into consideration. The Rev. C. F. Williams, a volunteer signal-service observer, who lives a few miles from the arsenal, has kept a record of the rainfall for a series of years. The most remarkable storm (taken from the record) occurred on July 13, 1889, when, in 10 consecutive hours, the rainfall was 4.37 inches, an average of less than $\frac{1}{2}$ inch per hour.

It is customary in making provision for storm water to assume the rate at 1 inch per hour; this will give 1 cubic foot of water per second per acre, for which drainage must be provided. Phenomenal storms or cloud bursts may occur, but it would be impracticable to make entire provision for drainage of storm water under such contingency without very greatly increasing the cost of the system, and it seems very desirable at the present time to make the cost a minimum, due regard being had for ample service, present and future.

Adams, in his work on sewers, drains, etc., assumes the rainfall is carried off in twice the time of fall. In his judgment, under no circumstances can over *two-thirds of 1 inch of rain*, falling in 1 hour, be delivered at the outlet of the sewer in the same time. Assuming the rainfall to be 1 inch per hour, the total catch of water on the roofs of all the buildings now contemplated (the area of same being 33,158 square feet) will be 0.766 cubic foot in 1 second. The proposed main will have a grade of $\frac{1}{142.8}$; for convenience in calculation, say $\frac{1}{144}$. With this grade it can be shown that a 6-inch pipe would discharge 0.46 (forty-six one-hundredths) of 1 cubic foot in 1 second and would provide drainage for a rainfall of 1 inch per hour. If the time of delivery at the outlet was twice that of the time of fall, the margin of safety would, in this case, be very small, and proper provision for future increase in the number of buildings would not be secured. If pipe 8 inches in diameter is used for the main, the grade being $\frac{1}{144}$, to find the uniform velocity, or velocity at outlet, pipe running full, provision being made for loss of velocity from friction, we have Adams's formula:

$$V = 50\sqrt{\frac{H}{L}D}, \text{ in which } \frac{H}{L} = \frac{1}{144.}\ D = \frac{8}{12} \text{ (all dimensions in feet); substituting}$$

for $\frac{H}{L}$ and D these values, we have $V = 50\sqrt{\frac{1}{144} \times \frac{8}{12}} = \frac{50}{1{,}216.}$

$$\begin{aligned} \log. 50 &= 1.698970 \\ \tfrac{1}{2} \log. 216 &= 1.167227 \\ \log. V &= 0.531743 \\ V &= 3.4 \text{ feet per second.} \end{aligned}$$

The discharge per second will be equal to the area of cross-section of the pipe, multiplied by the velocity at the outlet $Q = 7{,}854\ D^2V = 7{,}854 \times \frac{4}{9} \times 3.4 = 1.19$ cubic feet. This will be ample provision for a rainfall of $1\frac{3}{4}$ inches per hour, under the assumption that two-thirds thereof reaches the outlet in the time of fall. It is not believed that pipe of larger diameter will ever be required for future use at this arsenal. I would not consider it safe to use pipe of smaller diameter for this purpose; 8-inch pipe is therefore recommended for the main.

In order to secure an outlet for the main on Little Bigby Creek, it may be necessary to allow parties who give the right of way over their grounds the privilege of connecting with this main for sewerage purpose, should the development of their property in the future make this desirable on their part; indeed, the largest property-holder on the proposed line gives his consent to the laying of the main, reserving the right to make connection at any time. I can see no good objection to this arrangement.

The proposed main will be 8 inches in diameter; the grade being $\frac{1}{144}$, the velocity of outflow will be 3.4 feet per second, discharging, when running full, 1.19 cubic feet per second; in 16 hours the discharge would be $1.19 \times 60 \times 60 \times 16 \times 7.48 = 512{,}709$ gallons. If we allow 75 gallons of waste per day per person, all to be discharged in 16 hours, this main will have ample capacity to carry off all liquid waste and sewage for a population along its line amounting to 6,800. I do not believe the future necessities of this arsenal, taken in connection with whatever increase of population there may be in the neighborhood dependent on this main for sewerage, will ever require a pipe of larger diameter than the one proposed.

If sleeve pipe is used in the construction, as proposed, a section can be taken out at any time and replaced without disturbing other portions of the line. This operation being very simple, there would be no reason to fear obstruction of any kind by future connections.

In determining the size of pipe to be used on the laterals, we have to take into consideration the diameter of the soil pipe already adopted for use in the buildings. The diameter of all the soil pipe is 4 inches. In order to avoid as much as possible danger of stoppage of the flow of sewage in the laterals by the lodgment of solids or by the entrance of foreign materials, coarse paper, cloth, and other substances, which will sometimes find their way into soil pipes, these pipes should be somewhat larger in diameter than the latter; pipe 6 inches in diameter is recommended for this purpose.

The grade and the velocity of outflow for each lateral are given below. The velocities of outflow were calculated by use of Adams's formula:

Grade from storehouse to main $\frac{1}{20}$ velocity = 7.9 feet per second.

Grade from guard-house to main $\frac{1.5}{100}$ velocity = 4.3 feet per second.

Grade from office to main $\frac{1}{50}$ velocity = 5 feet per second.

Grade from officers' quarters to main $\frac{3}{100}$ velocity = 6 feet per second.

Grade from barracks to main $\frac{8}{100}$ velocity = 10 feet per second.

Grade from married men's quarters to main $\frac{1}{50}$ velocity = 5 feet per second.

The laterals have ample capacity to carry off storm water from the roofs of buildings when the rate of fall does not exceed 3 inches per hour. So far as the storm water is concerned, with the above grades, it would have been safe to use 4-inch pipe for the laterals, but the saving in cost by so doing would not have exceeded $150 and would not counterbalance the danger from stoppage of flow of sewage in the laterals heretofore taken into consideration.

Experiments have shown when the diameters of pipes are properly proportioned, and the velocity is as high as 2½ to 3 feet per second, no danger need be apprehended of the retention in the sewer of any material likely to reach them.

Whilst it is not believed that any system of sewers for house drainage can be self cleansing, the conditions in this direction are all exceedingly favorable; the velocities are high in all of the laterals, and in the main the velocity is greater than the minimum required for safety.

Ample provision has been made for flushing with storm water, and when the contemplated connection is made with the city water works there will, at all times, be an abundant supply of water at hand, which can be used as it may be required for this purpose.

Manholes are located at all junctions of main and laterals, at the division lines, and the outlet, to serve as points of observation and means of ventilation. Fresh air, finding an entrance at any one or all of the manholes, passes from the main to the laterals and finds an exit from them above the roofs of all buildings through the medium of the conductors attached thereto.

The soil pipes in all of the buildings project above the roof; they are trapped at their connection with the sewers, with an inlet so arranged that there is a constant circulation of fresh air throughout these pipes at all times; danger from poison by sewer gas is thus reduced to a minimum. Any obstruction on the line can easily be removed through the hand holes located at every station.

When designed it was supposed that by this method of ventilation of the soil pipes all danger from the air in the house pipes entering the rooms would be completely obviated; this might be so if there was always a strong upward draft through the soil pipe, but such is not the case.

In future constructions it is suggested that a ventilating pipe of the same size as the soil pipe be placed in the rear, or by the side, of the latter, extending from the lowest trap to the roof, every trap in the building connecting with the ventilator, as by this means "complete immunity from the inroads of sewer gas may be had."

In the commanding officer's quarters—office and barracks—the soil

pipes pass under the cellar floors, and in case of stoppage of pipes in either some difficulty would be met with in removing the obstruction. The proper construction is fully explained in your report on this subject, dated Frankford Arsenal, March 14, 1889, which is of such great importance that I take the liberty of quoting extract from the same, viz:

> The soil and waste pipes should run vertically down till they pass through the first floor to the cellar. They should then in no case whatever run down to the cellar floor. This is most important for health and for economy of both first cost and repairs. They should turn and run under the cellar ceiling to the side walls of the house, then down to just below frost line (outside), and then out through the side walls to sewers as near the ground surface as possible, both for good drainage and for ease of examination of sewer connections and down-spout ventilator connections outside. At the elbow at the bottom of the vertical pipe (inside the cellar) a screw plug should be placed and arranged for running a rod or wire up the whole length of the vertical pipe.
>
> To illustrate: in the commanding officer's quarters one soil pipe takes all the discharge from the two bath rooms. This pipe runs down in the corner of the storeroom, where it can be exposed. That from the servants' bath runs down in the corner of the laundry, where it can be exposed. Both of these pipes are to run vertically up to the attic and thence to the kitchen chimney for ventilation. All other waste or soil pipes are on the first floor and run naturally down through the floor to the cellar ceiling. Thence all run under the ceiling till they connect in one discharge pipe through the side wall to the sewer. It is better to have all these connections under the cellar ceiling, where they can be seen, than underground outside, where they can get out of order and poison the ground and house pipes in secret.

The appropriation of $200,000 made for this arsenal on May 1, 1888, has been expended, except the sum of $15.64, and all of the work contemplated by the Department, under this appropriation, has been completed. Since the above date no appropriation has been made. During the past year considerable damage has been done to the roads, partially completed, also to the grounds, by excessive rain, which could not be repaired on account of lack of funds to pay for the necessary work. The enlisted men have been kept constantly employed, and all has been done that could be accomplished with their help.

Provision should be made for fences, roads, walks, grading grounds, shade trees, and water supply.

At present the Columbia Improvement Company supplies water for the use of the post, charging $400 per year for same. The water is taken from Duck River, the pumping station being located on this stream below the point that receives the drainage from the city of Columbia. The stream is generally in a muddy condition, and during the summer months the surface is covered with scum and growth of algæ, all of which might affect the health of persons drinking same. The present method is expensive, and the Department can not regulate the price of delivery. To secure independence and an abundant supply of water it is proposed to construct a reservoir to catch rain water that falls on the roofs of the storehouse and shop and to pump water from this reservoir into tanks placed on the upper floor of the storehouse; from thence all buildings to be supplied through the water main already established. It is hoped an early appropriation can be secured for this purpose.

The work done by the contractor on all of the buildings is in harmony with the specifications in all respects. The only defects noticed up to the present time is a cracking of the plaster on the inner walls of the commanding officer's quarters, office, barracks, and enlisted married men's quarters, due entirely, in my judgment, to the use of poplar lath in all of these buildings. They were developed during the winter months, and it is believed the hot air from furnaces and stoves caused shrinkage of laths.

The stable was designed for the comfort of public animals, and possesses such features of interest that I think it would be permissible to quote in full your report on this subject, dated Frankford Arsenal, March 14, 1889, and which is as follows:

A horse should never be tied with his head to a wall. This fault is so general—almost universal—in the construction of stables that it seems not to be understood or appreciated.

It is bad for the horse's general health and is especially bad for his eyes and his disposition. In cold weather, or whenever the walls are colder than the interior air, there is a current of cold air falling along the walls on the horse's head. This current carries with it the fumes from the stable, and there is no ventilation at the horse's head. The usual remedy for these evils is to make a small opening over the horse's head. This, except in hot weather, is worse than the evils mentioned. It lets in a cold draft on the horse's head. The fault will be best appreciated if a man will imagine a great part of his life spent with his face tied to a dark wall and a hole above to let a cold draft in on his head, and his companions tied in the same way with their backs to his.

The horse stands with his eyes in the dark and is then suddenly taken out, often for violent exercise, with his unsheltered eyes in the sun. This is always bad, and when taken out in sunshine or snow is a fruitful and frequent cause of total blindness.

Usually there is another row of animals behind the horse on the other side of the stable. The horse can not see, but hears these animals. He is constantly worried and sometimes frightened by the noises or kicking of a restive animal, and he kicks at random. He strains at his halter to turn around and see. He is worse annoyed if interrupted by noises while feeding. This is bad for his health and especially bad for his temper and disposition. It is a serious evil. It is a very inconvenient construction, and I find it not economical. In feeding grain, the groom must pass into the stall beside the horse. The horse hears, but can not see the feeding, becomes restive, and when the groom arrives he struggles to get at him, and at the grain before it is put in the box. The arrangement is generally coupled with the bad one of feeding the hay in an elevated rack. This is to the horse an unnatural position for taking food. Also he gets straws, seed, and chaff in his eyes, ears, and nose. He is annoyed in trying to pick over the hay, and reject what he will not and should not eat, and which should be thrown out afterward for bedding. The openings for throwing down the hay are so located that they are buried when hay is taken in, must then be dug out, and the stablemen climb over the hay each time they feed and pull and dig out the hay from the wrong side of the pile each time they feed, usually in a dark place.

The reverse of the above plan for stables (see plans herewith) is to run a feed room through the center of the building, place a stable each side of it, and have the animals face the feed room and face each other on opposite sides of the same. This places the manure and stable fumes along the outer wall, where as many large windows for light and ventilation can be placed as are desirable. It furnishes every convenience for easy feeding, both hay and grain. All stablemen can be excluded from the feed room except the one responsible man, who feeds all animals, under orders. The horse has ample light and ventilation, both of which can be regulated at will. The value to the horse's disposition of having other horses where he can see them (provided they can not get their noses together) and enjoy companionship is underestimated. There are many minor advantages. It is a more economical arrangement.

Brick furnishes an excellent floor for horse stables. Next to rammed clay, it is about the best for the horse's feet. It is neat and economical. There is little wear, except just under the horse's feet, where he stands in his stall. When worn, these few bricks can first be turned till the other edges are worn and then renewed by the stablemen, with slight trouble and expense and without disturbing other parts. It permits varied and cheap arrangements for drainage and for changing the same to meet changed requirements for horses and mares. It does not interfere with planting stall partition posts. It gives a good foundation for rammed clay when diseased feet require it.

Respectfully submitted.

ISAAC ARNOLD, JR.,
Major, Ord. Dept., U. S. Army, Commanding.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

COLUMBIA ARSENAL, *July 23, 1892.*
(3724–'92.)

APPENDIX 12.

ANNUAL REPORT OF THE CHIEF ORDNANCE OFFICER, DEPARTMENT OF THE PLATTE.

HEADQUARTERS DEPARTMENT OF THE PLATTE,
OFFICE OF THE CHIEF ORDNANCE OFFICER,
Omaha, Nebr., August 31, 1892.

GENERAL: In compliance with paragraph 57, Ordnance Regulations, I have the honor to submit the following report of the operations of the Omaha ordnance depot and of this office during the past year.

OMAHA ORDNANCE DEPOT.

The depot now maintains only a reserve supply of ordnance stores necessary for field service, to be drawn upon should an emergency arise. The stock on hand consists of field equipments for about 300 infantry and 200 cavalry, and includes about 200,000 rounds of rifle ball cartridges, 100,000 carbine, 175,000 revolver, and 1,500 rounds of ammunition for the Hotchkiss mountain gun. All the stores have been overhauled during the year and are in excellent condition. The depot has only been called upon twice during the year for emergency issues. These were made to newly organized Indian companies, and were hurried in order to encourage enlistments. The stores necessary for the small-arms competition at Bellevue rifle range are also kept at the depot and have been issued as required.

ORDNANCE STORES.

The stores issued to troops by the Ordnance Department have, so far as I can ascertain, given entire satisfaction. Suggestions for changes have been made from time to time, but no complaints of bad material nor poor workmanship have been received. The efforts of the Department to improve the equipment of the infantry and cavalry soldier are fully appreciated by line officers. The new articles that have been sent out for trial during the year have been faithfully tested, and intelligent reports have been made.

THE WHIPPLE BIT.

The service curb bit (Shoemaker), though a handsome and scientific bit, is too heavy and not in accord with the principles laid down by the latest experimenters and theorizers in this field. Capt. Whipple, of the Ordnance Department, has made a very commendable effort to reconcile theory and practice in his bit. Two were sent to this Department last fall for trial. Upon the recommendation of cavalry officers the original

model has been twice modified. The last pattern seems to be satisfactory to the majority of the officers who tried it, and I have recommended that several troops be equipped with it for more exhaustive trial in actual service. The Shoemaker bit has been made with only one length of mouth piece, which was a great objection to it. Our cavalry officers are paying much more attention to fitting the bits to the horses' mouths than formerly, and are finding out that it is quite as important to fit the bit to a cavalry horse as to fit the collar to his brother in the artillery service. I would recommend that, if the Whipple bit is issued, it be made in several different widths.

NOSEBAGS.

Several patented nosebags and feed baskets have been tried in the department, but none have been found more satisfactory than the service pattern. During the trials, however, the fact was devoloped that the ventilation of the ordinary nosebag is defective. I therefore recommend the addition of a perforated leather ventilator in the front of the bag at about the place where the nostrils of the horse would naturally come in eating out of it. Several bags were made with this addition, and they were received with much favor by cavalry officers It is recommended that the ventilator be added to all nosebags.

LARIAT STRAPS.

This is a strap about 8 inches long riveted to the ring of the picket pin and having a steel snap at the disengaged end. When the lariat is coiled the strap is passed around the folds through the ring of the picket pin and then snapped into a saddle ring. The device is very simple and effective and its adoption with a few minor changes has been recommended. It was invented by Sergt. Edward Suschanke, of Company F, Fifth Cavalry.

In connection with the trial of this strap I recommended that brass rings with screw eyes be substituted for the rings with ordinary staples, as the latter frequently pull out. It is very important that these rings be made thoroughly secure.

HOOF HOOKS.

Having had several applications for hoof hooks, I made a sketch of a simple steel hook that I thought would answer the purpose and suggested that it be tried. One hundred were manufactured by the Department and sent to me for trial. Reports have as yet been received from only two troops. These are favorable, and it is probable that the hook will be satisfactory. It is very cheap and portable.

HORSE COVERS.

Two canvas horse covers, with extra strong fastenings and overlapping in front, were sent here for examination last fall, but the demand for a blanket-lined horse cover for winter service is so universal among cavalry officers that I do not think any other will be acceptable. I recommended in my report of October 31, 1891, to which I appended the opinions of most of the cavalry officers in the Department supporting my recommendation, that the canvas cover be given up altogether and that a suitable blanket-lined cover be substituted for service in northern latitudes.

GUN SLINGS WITH EXTRA HEAVY HOOKS.

Observing that most of the gun slings presented to me for condemnation had the hooks broken, I recommended that they be made with heavier hooks. Some samples were made and they have stood the trials given them admirably. These hooks are fully as strong as the slings and do not look at all clumsy. They were much liked at the rifle competition. I would recommend that all future manufactures of gun slings be equipped with these hooks.

ALUMINUM BRONZE FIRING PINS.

These firing pins have been substituted for the old steel ones in the rifles and carbines throughout the department, and have given general satisfaction.

THE MERRIAM PACK.

In my last annual report I referred to this equipment as having an excellent chance of success provided the method of support and adjustment was simplified. Col. Merriam has been working on this problem and has apparently solved it in his last pattern of the pack. There are now only three adjustments, dependent only upon the height of the men, no straps to become tangled, and any soldier ought to be able to use the system without difficulty. I sent to the Ordnance Office May 14, 1892, one of the new packs and recommended that 1,000 be made for further trial. Five hundred have been ordered, and I shall watch their trial with much interest. The Seventh Infantry is now completely equipped with the Merriam pack. I had the pleasure of witnessing a drill last month by the battalion at Fort Logan with loaded Merriam packs and full field equipment. The regiment made a very fine appearance.

HOTCHKISS GUN PACK.

Last fall I met Mr. Thomas Moore, chief packer of this department, and conversed with him in regard to the defects developed in the Hotchkiss gun pack during the Pine Ridge campaign. The pack outfit was remarkably successful for a new and untried equipment, but a few points were overlooked in manufacture. Several of these I called attention to immediately after the campaign, and recommended that the offer of Capt. Allyn Capron, First Artillery, to assist in perfecting the gun pack and remedying some minor defects in the harness be accepted. From Mr. Moore I learned that the ammunition pack disabled all the mules that were used with the full load of 72 rounds. The reason seemed plain, that the load was carried too low, with 3 boxes on each side, and brought too great a lateral pressure on the vital parts of the mule. After correspondence with Mr. Moore, I recommended that the ammunition boxes be made 2 inches deeper, so as to hold 8 instead of 12 rounds each, and that 4 boxes instead of 6 constitute a load. This throws the load well up on the animal's back, and the same amount of ammunition is carried as before. It is hoped that these changes will be made, so that the pack can be experimented with next summer. There are 4 guns in the department unprovided with packing outfits.

SHOTGUNS.

I wish to renew the recommendation I made in my report for 1890, that the Ordnance Department issue to troops and companies double-barreled shotguns, No. 10 bore, instead of the single-barreled, No. 20 bore, guns now used. The Springfield shotgun makes a fair pattern at 40 yards, and is a good gun for its small cost, but it is far from being on a par with the other arms issued by the Department. A good serviceable double-barreled breechloader could probably be obtained for about $30, and would be appreciated by the troops of the line. The stores issued by the Ordnance Department have always been the best of their kind, but our present shotgun is certainly an exception to this rule. A good gun should be issued, or none at all.

INTRENCHING TOOL.

I have before called the attention of the Bureau to the inadequacy of the hunting knife (or intrenching knife, as it is now called) for intrenching purposes. The old Hagner intrenching tool is much preferable to the knife. If nothing better can be suggested, I would recommend going back to the Hagner, which was really a very fair intrenching tool, and could be used as a knife or hatchet.

THE TIN CUP.

The least satisfactory article of the equipment is the tin cup. The practice of plains men and miners is valuable in this instance. They use a cup stamped out of heavy tin, which is, of course, entirely seamless. It can be battered out of shape but will still hold water. The service cup, being of cylindrical shape, is difficult to carry, and if struck or crushed is worthless, as the soldered seam at the bottom or along the side at once gives way. I would recommend that a cup stamped out of a single piece of tin with the corners rounded off, similar to the ordinary miners' cup, be issued. The handle could be riveted on as it is now.

SMALL ARMS.

The Army is looking with much interest for the report of the Magazine Gun Board. The Springfield rifle and carbine have been developed to their present perfection by years of labor, and line officers and men will require to be thoroughly convinced of the superiority of a new arm before they will be ready to abandon the old reliable Springfield. The scores at the infantry competition of the Department of the Platte this summer again showed a satisfactory increase. The gain in the aggregate scores of the first ten men was 322 points, and the first man excelled his score of last year by 40 points, making 630 out of a possible 800.

THE METRIC SYSTEM.

At the risk of going outside of the strict province of a department report, I wish to make a recommendation to which I have given much thought.

The English system of weights and measures is acknowledged to be very defective, both as to convenience and accuracy. I think no one will deny that a decimal system is infinitely more convenient than any

other, and certainly the differences between pounds Troy, avoirdupois, and apothecaries' weight, tons English and American, etc., are of no advantage. The only objection to changing at once to the metric system, which is used in all European countries, is the difficulty of educating the people in its use. We have abandoned the absurd monetary system of the English and adopted a decimal system; why should we not also take a scientifically constructed decimal system of weights and measures? What I would suggest is, that the Ordnance Department of the Army begin the process of educating the people by using the metric system in all of its shops and offices. Let the caliber and other elements of our guns be known by the system used by all the world, except our ultraconservative English cousins, and the trades will soon follow our lead. We have already attempted to force a decimal system upon the English table of linear measure by subdividing the inch into hundredths and thousandths, and we might as well go further. If the Ordnance Department of the Navy would coöperate, or, better still, if Congress could be brought to impose the metric system upon all Government work, the people would soon appreciate its advantages and voluntarily adopt it. The system was authorized by Congress in 1866, but little has been done since to popularize its use. As the Department whose work requires the most elaborate calculations and most minute measurements, it seems to me quite appropriate that we should take the initiative in this important matter.

Very respectfully, your obedient servant,

J. C. AYRES,
Capt., Ord. Dept., Chief Ordnance Officer.

The CHIEF OF ORDNANCE, U. S. ARMY.

(4572–'92.)

APPENDIX 13.

STEEL FOR SMALL-CALIBER RIFLE BARRELS.

(4 plates.)

SPRINGFIELD ARMORY,
Springfield, Mass., June 10, 1892.

SIR: Complying with your instructions of March 15, 1892, I have now the honor to submit the following report on the manufacture of gun barrels at this armory, since the adoption of steel for the purpose:

* * * * * * *

The steel used here in the barrels .30 caliber so far made has had a tensile strength of about 85,000 pounds, an elastic limit of about 45,000 pounds, and an elongation of 25 per cent.

One of these barrels sent to Frankford Arsenal was reported in September, 1891, as having deteriorated to such an extent that the velocity had fallen off from 100 to 200 feet; this was verified at this armory and reported upon by the commanding officer October 16, 1891.

Within the last few days it has been stated here that a second barrel of the same make in use at Frankford Arsenal has deteriorated, judged from the falling off in velocity of the projectile. The circumstances attending this injury and the extent have not yet become known to the commanding officer of the Armory.

One sample of steel submitted for .30 caliber barrels has given a tensile strength of 113,000 pounds, elastic limit 72,000 pounds, and elongation 15 per cent. Other samples are being received and will be tested from time to time for physical properties, but until sufficient smokeless powder for the purpose may be obtained here no test of gun barrels can be made. Such tests should be made as soon as possible, and barrels for the purpose will be prepared at once, if the Department so authorizes.

Through the courtesy of the Board on Magazine Arms, there are forwarded herewith drawings showing a longitudinal section, with dimensions for interior and exterior diameters, etc., so far as they could be determined, of the barrels of the following guns before the Board on Magazine Arms, and also of the barrels of the Springfield rifles, calibers .45 and .30, viz:

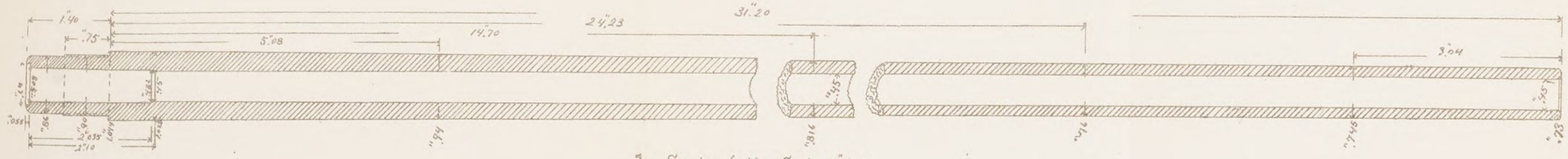
1. Springfield, caliber .45.
2. Springfield, caliber .30.
3. Mannlicher (Austrian).
4. Mannlicher (Roumanian).
5. German Infantry.
6. Mauser (Belgian).
7. Mauser (private; from inventor).
8. Krag-Jörgensen (Danish).
9. Krag-Jörgensen (private; from inventor).
10. Lee-Speed (English).
11. Schmidt (Swiss).
12. Murata (Japanese).
13. Kropatschek (Portuguese).
14. Mannlicher carbine (Austrian).
15. Springfield, caliber .30, April, 1892.

Respectfully, your obedient servant,

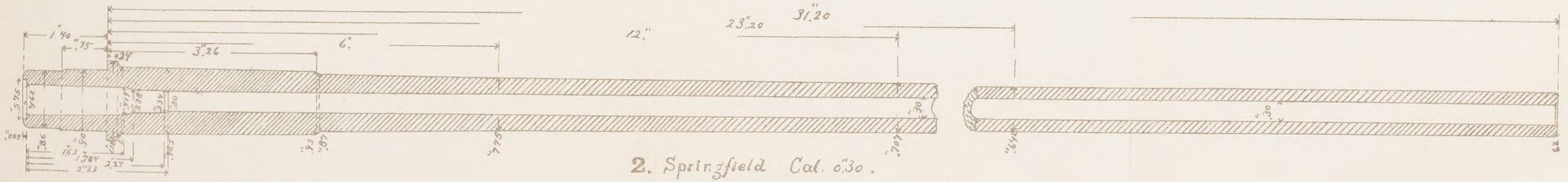
A. MORDECAI,
Col., Ord. Dept., U. S. Army, Commanding.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

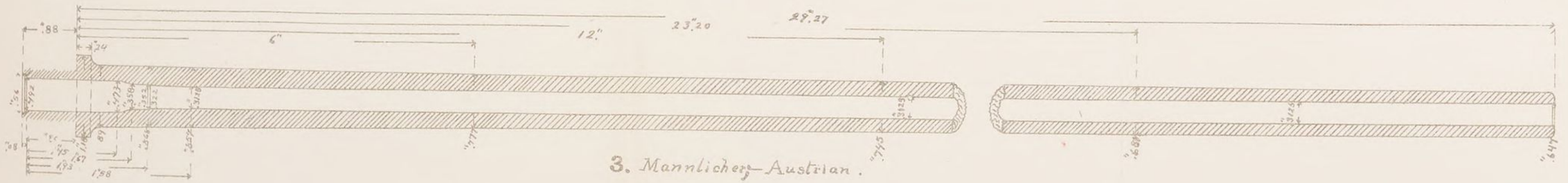
(2885–'92.)



1. Springfield Cal. .45.



2. Springfield Cal. .30.



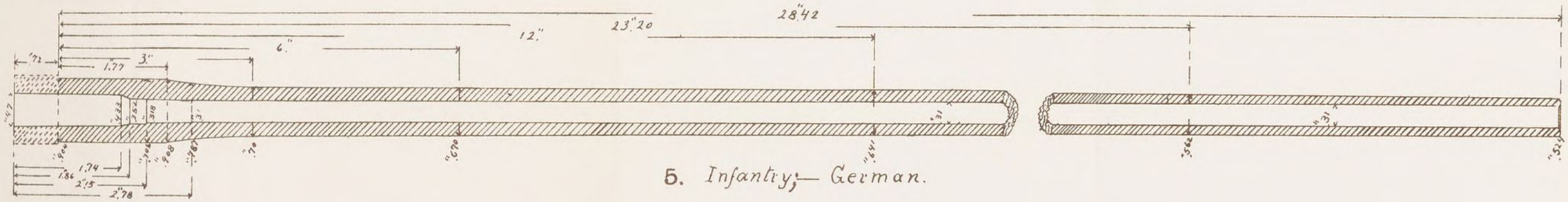
3. Mannlicher—Austrian.

4. Mannlicher—Roumanian.

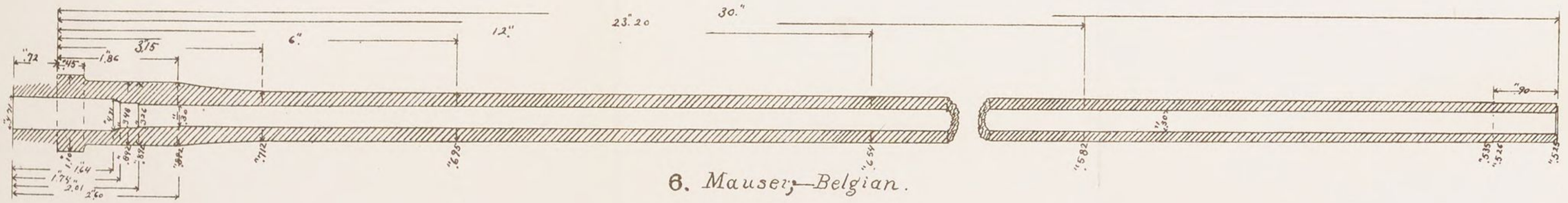
Springfield Armory.
JUNE 10, 1892.

Colonel Ord. Dept.
Commanding.

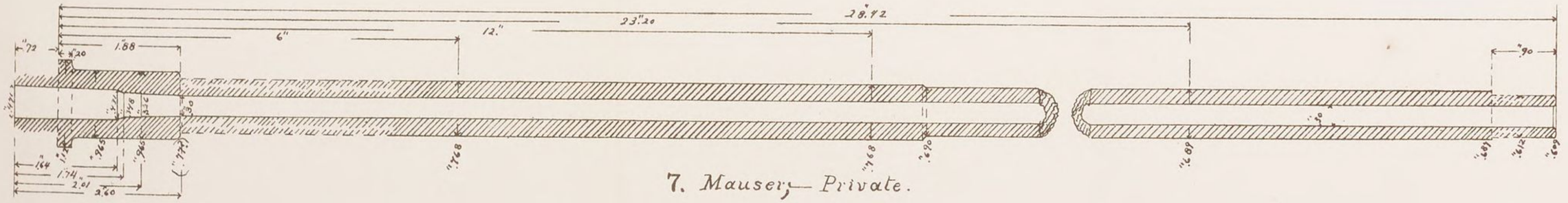
Appendix 13, 1892.



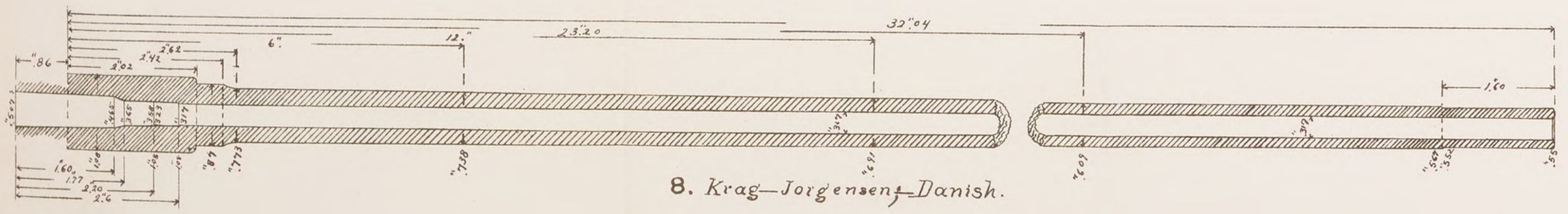
5. *Infantry,— German.*



6. *Mauser,—Belgian.*



7. *Mauser,— Private.*



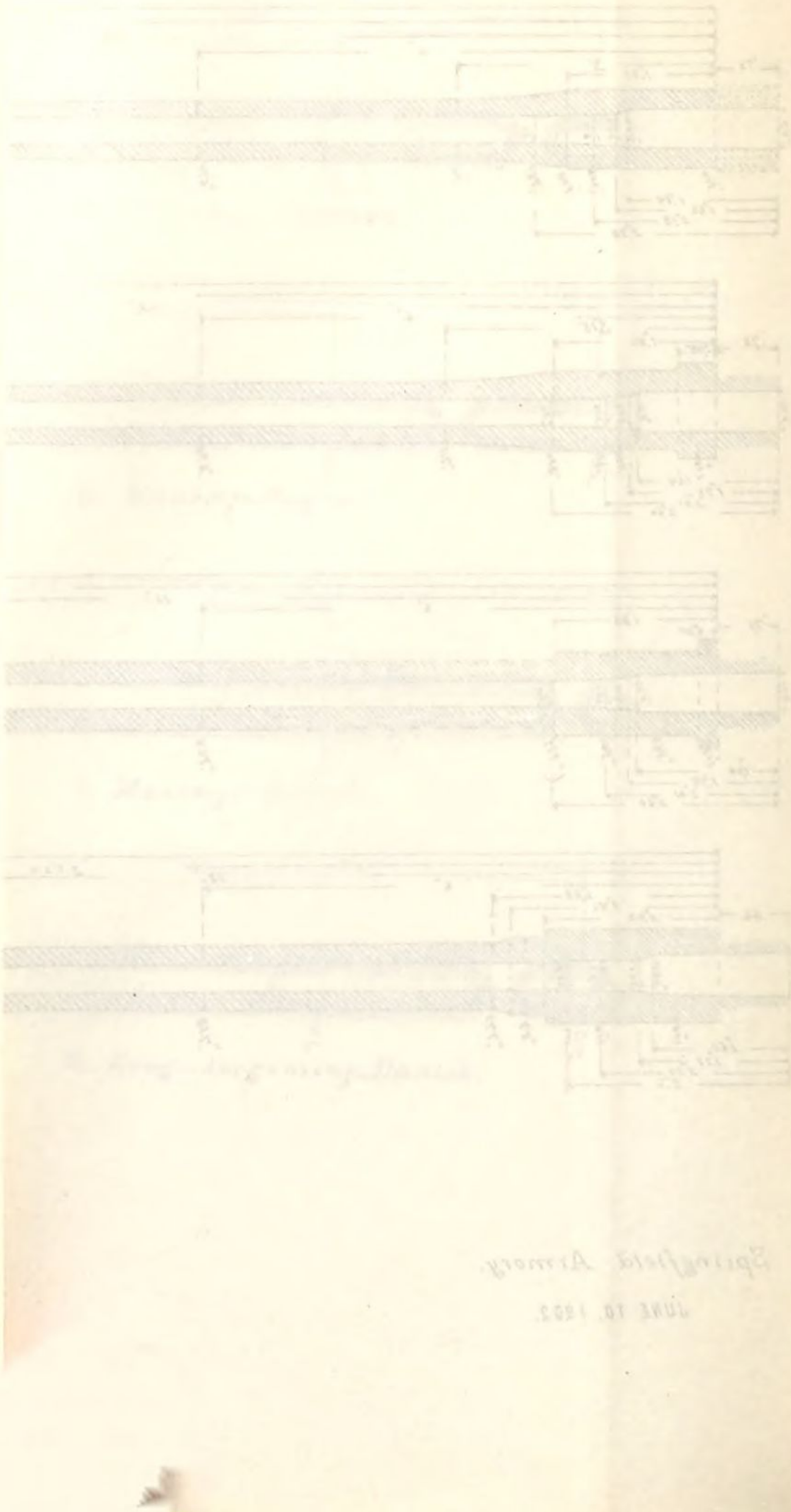
8. *Krag—Jorgensen,—Danish.*

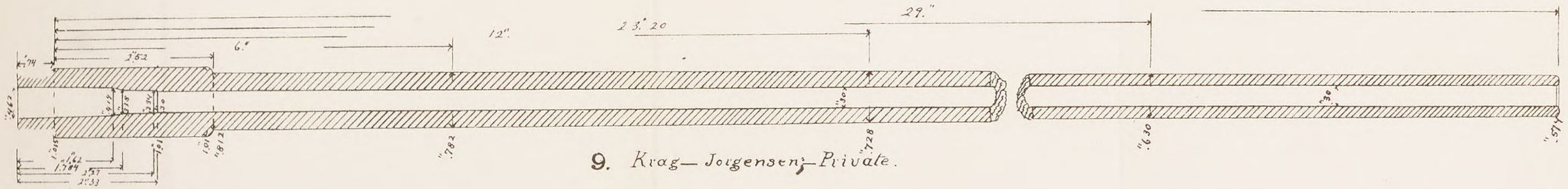
Springfield Armory.

JUNE 10, 1892.

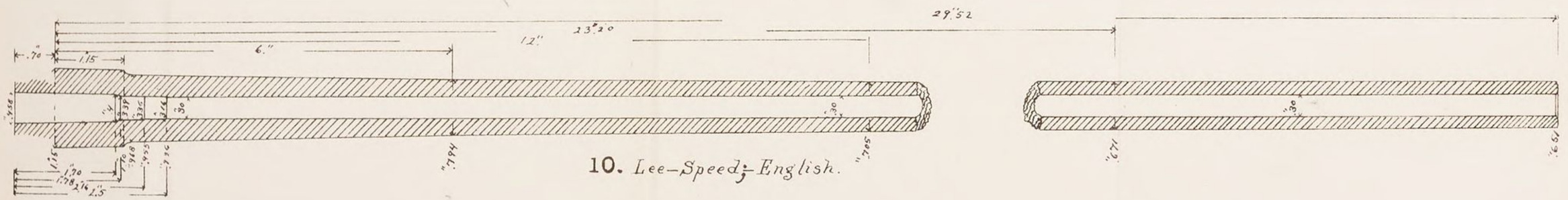
A Mordecai
Colonel Ord. Dept.
Commanding.

Appendix 13, 1892.

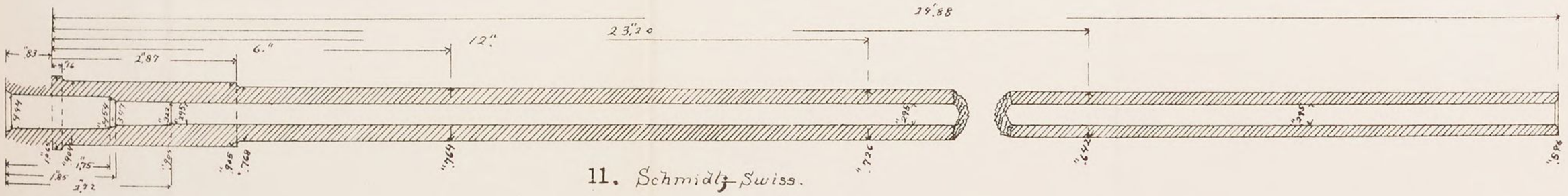




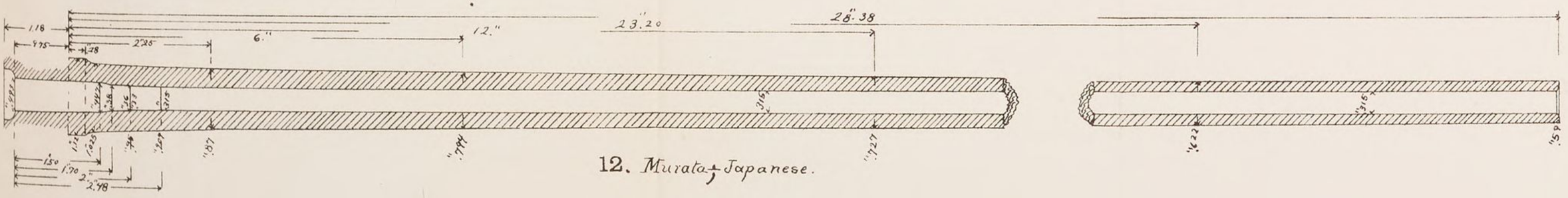
9. *Krag—Jorgensen—Private.*



10. *Lee—Speed—English.*



11. *Schmidt—Swiss.*



12. *Murata—Japanese.*

Springfield Armory.
JUNE 10, 1892.

A. Mordecai
Colonel Ord. Dept.
Commanding.

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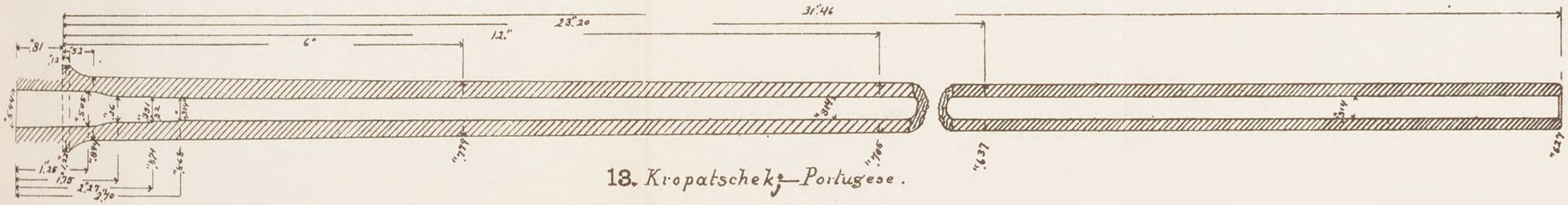
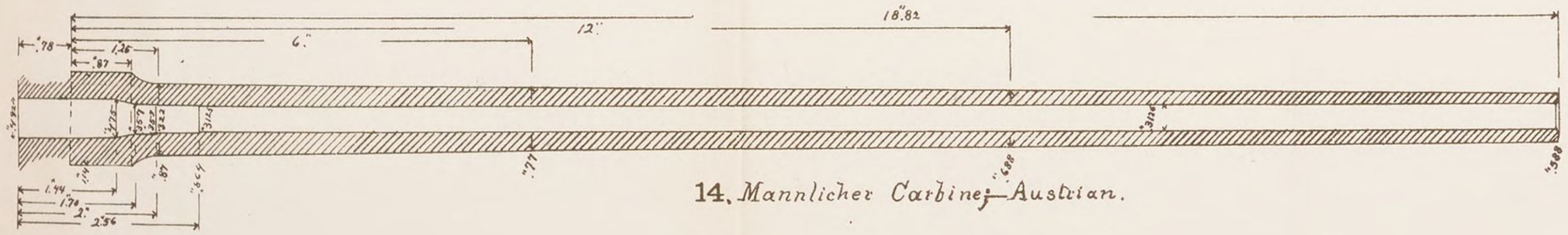
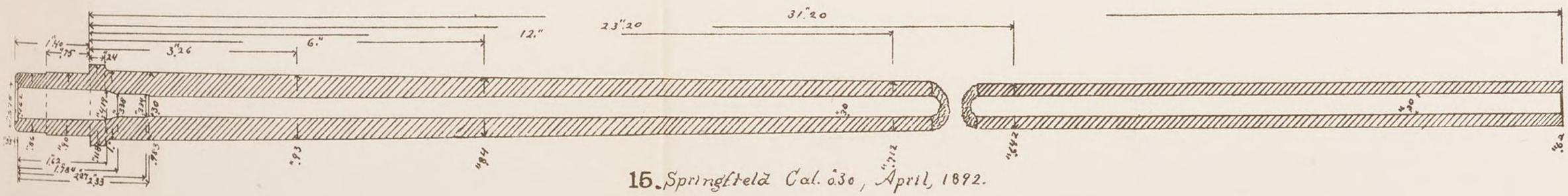


13. *Kropatschek*—*Portugese.*



14. *Mannlicher Carbine*—*Austrian.*



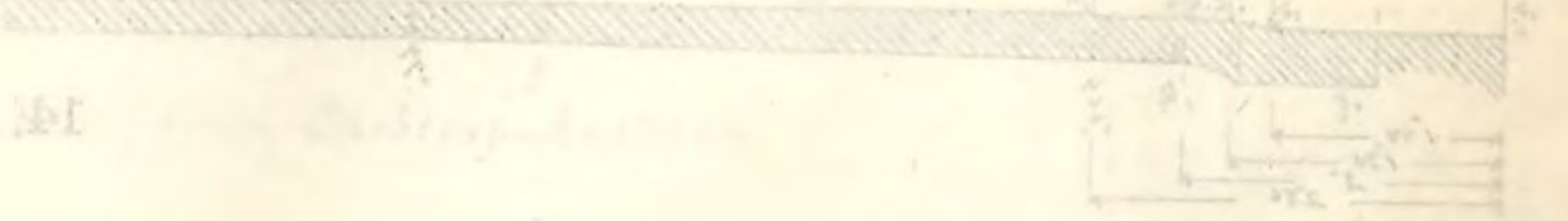
15. *Springfield Cal. .30, April, 1892.*

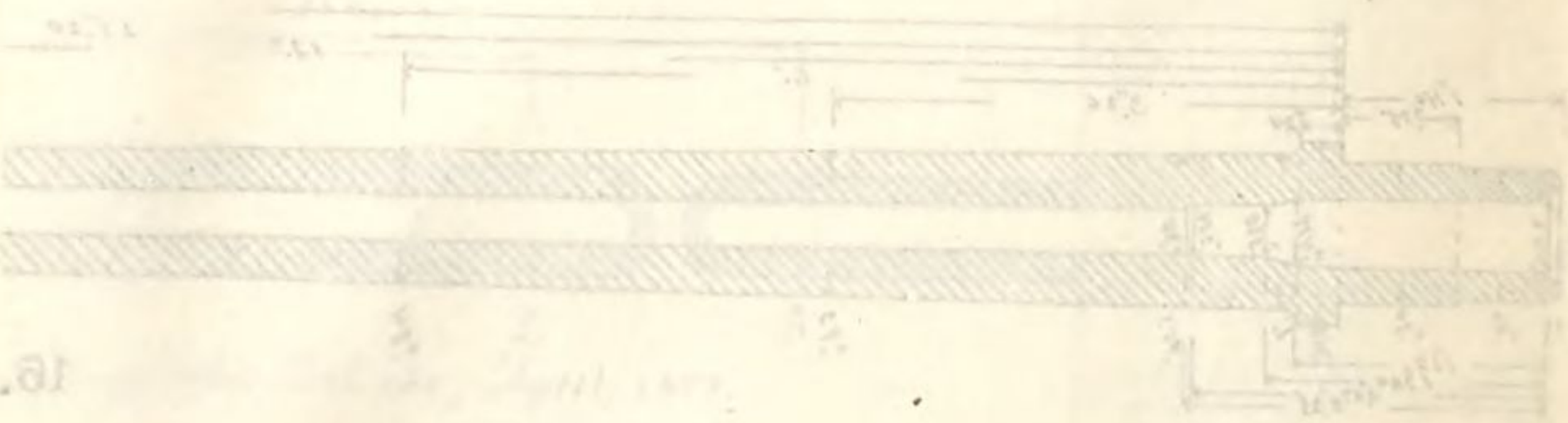
Springfield Armory.

JUNE 10, 1892.

A. Mordecai
Colonel Ord. Dept.
Commanding.

Appendix 13, 1892.





APPENDIX 14.

REPORTS ON SMOKELESS POWDER.

No. 1.

REPORT ON WETTEREN SMOKELESS POWDER.

SPRINGFIELD ARMORY,
Springfield, Mass., January 26, 1892.

SIR: I have the honor, in accordance with your verbal directions, to submit report of additional trials lately made of the Wetteren powder used in the cartridges employed by the Board on Magazine Arms in their tests of guns submitted.

The powder now tested is some of a lot received at this Armory from Belgium in April of last year and then immediately tested. The results obtained were decided subsequently to be not entirely reliable, it being thought the powder had not recovered from the influence of the sea voyage.

Further experiments were accordingly made early in May and again about the middle of June, 1891, and the results embodied in Appendix 13 of the Report of the Chief of Ordnance for 1891. To them attention is requested in this connection.

During the past seven months the powder has been kept in a tin canister in a room maintained (except during the heat of summer) at an even temperature of about 70°. The powder has been used from time to time, but except at such periods the canister has been kept closed. The conditions of storage may then be considered about normal.

The trials made this month have occupied nearly two weeks, about ten shots only being fired each day.

The cartridges for each firing were loaded but a few hours before using, great care being exercised that variations in the charge should not exceed one-tenth of a grain.

The length of time occupied in the trials tending to eliminate the influence of local changes in temperature and moisture, and the loading room and firing gallery being maintained at a uniform heat, the results found can probably be deemed independent of external circumstances.

Charges of 33, 34, 35, 36, and 37 grains were fired in the caliber .30 Springfield pressure barrel, with the Frankford experimental bullet, lead with copper cannelured jacket, weighing 230 grains.

The following results were obtained:

Wetteren smokeless powder.

Charge.	Shot.	Pressure.	Instrumental velocity.
		Pounds.	*Feet.*
33 grains.....	1	47,600	1,734
	2	42,200	1,741
	3	44,000	1,737
	4	44,600	1,721
	5	43,800	1,764
	6	48,400	1,762
	7	40,000	1,714
	8	35,600	1,718
	9	41,900	1,722
	10	39,500	1,767
Mean		42,760	1,738
Corresponding muzzle velocity..		.....	1,772
Average variation from mean.....		2,920	16.4
34 grains.....	1	52,800	1,808
	2	49,000	1,797
	3	48,400	1,802
	4	52,200	1,802
	5	44,600	1,802
	6	43,200	1,781
	7	44,300	1,799
	8	46,600	1,770
	9	46,100	1,810
	10	48,400	1,806
Mean		47,560	1,797.7
Corresponding muzzle velocity .		.....	1,833.1
Average variation from mean..		2,600	9.0
35 grains.....	1	57,200	1,904
	2	55,700	1,912
	3	51,400	1,855
	4	56,600	1,904
	5	48,400	1,892
	6	47,600	1,854
	7	52,800	1,902
	8	47,000	1,875
	9	57,200	1,910
	10	49,900	1,864
	11	51,700	1,854
	12	53,400	1,881
	13	50,400	1,902
	14	53,200	1,881
	15	50,400	1,888
	16	47,900	1,875
	17	48,400	1,870
	18	44,300	1,854
35 grains.....	19	49,200	1,847
	20	44,000	1,860
Mean		50,835	1,879.2
Corresponding muzzle velocity .		.....	1,916.2
Average variation from mean		3,168.5	18.4
36 grains.....	1	59,200	1,918
	2	57,700	1,972
	3	48,400	1,860
	4	52,200	1,938
	5	58,200	1,932
	6	54,700	1,948
	7	56,200	1,948
	8	56,200	1,932
	9	56,200	1,918
	10	59,400	1,958
	11	47,600	1,902
	12	56,200	1,932
	13	52,200	1,890
	14	52,600	1,892
	15	54,800	1,890
	16	50,400	1,859
	17	60,700	1,888
	18	47,600	1,876
	19	57,400	1,930
	20	52,200	1,888
Mean		54,505	1,913.5
Corresponding muzzle velocity .		.....	1,951.2
Average variation from mean		3,284	27.7
37 grains.....	1	62,900	1,952
	2	65,400	2,000
	3	60,200	1,960
	4	62,400	1,986
	5	59,200	1,972
	6	57,400	1,956
	7	51,200	1,952
	8	58,400	1,980
	9	54,200	1,980
	10	59,200	1,980
Mean		59,050	1,971.8
Corresponding muzzle velocity .		.....	2,010.5
Average variation from mean		3,000	13.4

The velocities are instrumental, 50 feet from the muzzle. The muzzle velocities are computed therefrom by the table and formula of Capt. Ingalls.

For convenience of examination, the results of the trials made last May and June are tabulated below, in connection with those just obtained.

Wetteren powder.

Date.	Charge, 33 grains.			Charge, 34 grains.			Charge, 35 grains.			Charge, 36 grains.		
	Number of shots.	Mean pressure.	Mean instrumental velocity.	Number of shots.	Mean pressure.	Mean instrumental velocity.	Number of shots.	Mean pressure.	Mean instrumental velocity.	Number of shots.	Mean pressure.	Mean instrumental velocity.
		Lbs.	*Feet.*		*Lbs.*	*Feet.*		*Lbs.*	*Feet.*		*Lbs.*	*Feet.*
May, 1891 ..	20	50,010	1,855.1	15	52,853	1,897.1	15	55,900	1,954.9	10	62,530	2,015.2
June, 1891 .	10	48,010	1,819.8	10	51,510	1,852.4	10	55,880	1,926.7	10	60,960	1,981.6
Jan., 1892 ..	10	42,760	1,738.0	10	47,560	1,797.7	20	50,835	1,879.2	20	54,505	1,913.5

It will be observed there has been a progressive deterioration in the powder, quite marked for the limited period (six weeks) between the first and second sets of trials, and showing during the following seven months' interval an even greater total change, though less in proportion to the time. Between May and June this average loss of velocity for all the shots of the four different weights of charge was about 35 feet. In the next seven months an additional average loss of about 63 feet has occurred.

Further examining the table it will be observed that a change of 1 grain in the weight of the charge alters the pressure about 3,500 or 4,500 pounds and the velocity about 50 or 60 feet.

In the report of June 19, 1891, it was recommended that the charge for the cartridges to be used by the Board on Magazine Arms be fixed at 34 grains, this giving a pressure, as indicated by the methods followed at this Armory, of between 50,000 and 55,000 pounds. It would now appear that an increase of the charge to 36 grains would still leave the mean indicated pressure below this higher limit, and it is accordingly recommended that in all cartridges hereafter loaded for the board that amount of the Wetteren powder be used.

With such a charge in the Springfield caliber .30 gun (known as No. 2 on the records of the board) the following velocities were obtained. It will be noticed that the mean muzzle velocity slightly exceeds 2,000 feet:

Shot.	Instrumental velocity.	Shot.	Instrumental velocity.	Shot.	Instrumental velocity.
	Feet.		*Feet.*		*Feet.*
1	1,946	10	1,944	18	1,986
2	1,910	11	1,972	19	1,980
3	1,946	12	1,962	20	1,976
4	1,968	13	1,972		
5	1,980	14	1,970	Mean	1,968.1
6	2,006	15	1,990	Muzzle	2,006.8
7	1,958	16	1,966	Average variation	14.5
8	1,982	17	1,972		
9	1,976				

These velocities are nearly 55 feet in excess of those determined with the same charge in the pressure barrel, a difference between the two barrels greater by about 10 feet than existed some eight months ago. More extended trials might possibly eradicate this discrepancy, but even if maintained it shows but very slight degradation in the pressure barrel, in spite of the fact that it has been fired many hundred rounds more than that in the gun before the Board on Magazine Arms.

In the execution of the firing given in this report I have been assisted by Lieut. F. P. Peck, Ordnance Department.

Very respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord. Dept., U. S. Army.

Col. A. R. BUFFINGTON, *Commanding.*

(534–'92.)

No. 2.

SPRINGFIELD ARMORY,
Springfield, Mass., December 28, 1891.

SIR: In accordance with your verbal directions I have the honor to make the following report of the test of a sample of smokeless powder lately received through the Ordnance Office, from the United States military attaché at London, England.

Maj. Post's letter transmitting the powder stated that it was manufactured by the new explosive company at Stowmarket, England, and that it was said to be made almost exclusively from gun-cotton, dissolved and pressed into the proper form, without the addition of nitroglycerine or any other material except the solvent.

The powder came in the form of completed cartridges for the English .303-inch magazine rifle, containing, it was represented, 38 grains, and giving for 20 shots a mean initial velocity of 2,059 feet, with a mean difference of 9 feet.

One of the English magazine rifles being available, twenty of the cartridges, as received, were first fired from it, with the following results:

Shot.	Instrumental velocity.	Shot.	Instrumental velocity.	Shot.	Instrumental velocity.
	Feet.		*Feet.*		*Feet.*
1	1,964	10	1,934	19	1,872
2	1,926	11	1,974	20	1,916
3	2,018	12	1,930		
4	2,004	13	1,914	Mean	1,928
5	1,954	14	1,852	Muzzle	1,966
6	1,942	15	1,926	Average variation from mean	29.7
7	1,908	16	1,887		
8	1,929	17	1,904		
9	1,914	18	1,892		

It will be observed that the mean initial (instrumental) velocity is about 130 feet less and the mean difference about three times greater than claimed for the ammunition.

Removing several bullets they were found to weigh 217 grains, but it was discovered that the charge was only 37½ grains instead of 38; this may account for the loss of about 30 or 40 of the 130 feet in velocity.

A sufficient amount of the ammunition was then broken up to obtain powder for test in the Springfield caliber .30 pressure barrel, using in that the Frankford bullet of 230 grains, lead with copper cannelured jacket. The following results were obtained:

Charge.	Shot.	Pressure barrel, caliber .30.		Charge.	Shot.	Pressure barrel, caliber .30.	
		Pressure.	Instrumental velocity.			Pressure.	Instrumental velocity.
		Pounds.	*Feet.*			*Pounds.*	*Feet.*
30 grains	1	34,500	1,547	35 grains	6	55,200	1,764
	2	35,000	1,553		7	57,400	1,797
					8	53,400	1,778
33 grains	1	50,800	1,676		9	59,400	1,780
	2	45,800	1,617		10	59,200	1,758
34 grains	1	51,000	1,770	Mean		57,290	1,774.2
	2	46,800	1 733	Corresponding muzzle velocity			1,809.1
	3	49,600	1,769	Average variation from mean		1,787.5	16.8
	4	43,800	1,743				
	5	52,400	1,797				
	6	51,200	1,711				
	7	53,400	1,735	36 grains	1	63,600	1,850
	8	56,700	1,719		2	63,400	1,852
	9	46,800	1,654		3	68,000	1,892
	10	51,700	1,718		4	66,600	1,871
					5	63,400	1,878
Mean		50,340	1,734.9		6	69,800	1,860
Corresponding muzzle velocity			1,769.0		7	66,600	1,873
					8	63,400	1,857
Average variation from mean		2,872	27.9		9	60,500	1,887
					10	63,000	1,918
35 grains	1	58,200	1,766	Mean		64,830	1,873.8
	2	59,400	1,800	Corresponding muzzle velocity			1,910.7
	3	57,200	1,746	Average variation from mean		2,336	16.0
	4	56,500	1,800				
	5	57,000	1,753				

The preceding tables show this powder to be much inferior to the Houghton and Maxim (the best previously tested here), and also to the Wetteren, giving, as compared with the latter, for approximately corresponding pressures a lower velocity by 120 to 140 feet.

The granulation of the powder is not regular, nor is it entirely free from dust; in appearance it somewhat resembles the Wetteren, but has not its distinctive odor. It gives barely a trace of smoke and, except some partly unburnt grains, leaves no fouling in the barrel. These unburnt grains were also observed in front of the muzzle of the gun on the floor of the gallery.

Respectfully submitted.

S. E. BLUNT,
Capt., Ord. Dept., U. S. Army.

Col. A. R. BUFFINGTON,
Commanding.

No. 3.

FIRST REPORT ON TROISDORF SMOKELESS POWDER.

SPRINGFIELD ARMORY,
Springfield, Mass., December 30, 1891.

SIR: I have the honor, in accordance with your verbal directions, to make the following report of the trial of a sample of powder received through the Ordnance Office from the United States military attaché at Vienna, Austria, who had procured it from the Rheinisch-Westphälische Sprengstoff Geselschaft. The agent of that company when supplying the powder reported that, with a charge of 42½ grains and a bullet of 226 grains, an initial velocity of 2,165 feet was obtained. In what small arm was not mentioned, but as this is a German powder and the weight of the bullet used was the same as that in the cartridges furnished the Board on Magazine Arms for the test of the German infantry rifle, it is presumed that gun was intended.

The powder is in thin, flat grains, varying from 0.012 to 0.025 inch in thickness, with the surface of the grains about square or rectangular and running from 0.05 to 0.08 inch on a side. The natural color of the powder is a light drab, converted to more of a metallic brown by a slight coating of graphite. It is almost entirely free from dust. Ignited, when unconfined, it burns slowly, with a strong flame of a reddish tinge, devoid of smoke and leaving no ash. In the gun it is almost absolutely smokeless, gives no unpleasant odor, and barely a trace of fouling in the barrel, even after a number of shots. It is easily loaded into cartridges, and in spite of the inequalities mentioned appears to the eye to be fairly uniform in size.

After a preliminary charge of 33 grains, which gave an instrumental velocity of 1,821 feet and an indicated pressure of 45,600 pounds, the following results were obtained with charges of 36, 37, and 38 grains, all fired from the caliber .30 Springfield experimental pressure barrel, with a bullet (lead with copper jacket, having three lubricated cannelures) weighing 230 grains.

Charge.	Shot.	Pressure barrel. caliber .30.		Charge.	Shot.	Pressure barrel, caliber .30.	
		Pressure.	Instrumental velocity.			Pressure.	Instrumental velocity.
		Pounds.	*Feet.*			*Pounds.*	*Feet.*
36 grains.....	1	56,600	1,964	37 grains.....	9	61,400	1,990
	2	52,600	1,966		10	55,000	2,038
	3	55,200	1,950				
	4	50,200	1,885	Mean.....		58,220	1,981.4
	5	50,400	1,904	Corresponding muzzle velocity.		.....	2,020.3
	6	53,200	1,920				
	7	52,600	1,915	Average variation from mean.....		3,424	30.2
	8	54,700	1,976				
	9	54,800	1,950				
	10	51,000	1,946	38 grains.....	1	62,400	2,046
					2	61,400	2,046
Mean.....		53,130	1,937.6		3	61,200	1,980
Corresponding muzzle velocity.		.....	1,975.8		4	64,400	2,012
					5	56,500	2,006
Average variation from mean.....		1,770	25.3		6	56,500	1,968
					7	60,800	2,018
37 grains.....	1	53,400	1,930		8	56,200	1,960
	2	53,400	1,946		9	64,000	2,015
	3	56,600	1,962		10	60,200	1,962
	4	57,300	1,942				
	5	61,000	2,002	Mean.....		60,360	2,001.3
	6	63,600	2,022	Corresponding muzzle velocity.		.....	2,040.7
	7	56,500	1,976				
	8	64,000	2,006	Average variation from mean.....		2,408	27.0

Of the various powders tested at this Armory in the last eighteen months the best results have been found with the Houghton and one of the forms of Maxim, and they consequently have been taken as a standard in judging others.

Thus viewed, this powder appears as nearly, but not quite, up to the established standard, giving with about equal pressures a lower velocity by only about 50 to 70 feet. From shot to shot also the variations of pressure and velocity are not very great, being both within the limits which it would appear must be anticipated from smokeless powders.

The German army rifle, Model '88, lately tested by the United States Board on Magazine Arms, and a number of bullets and primed shells received from Germany for that gun being available for further test of this powder, comparative trials were made in it and in the Springfield No. 2, also lately tested by the above-mentioned board.

These guns differ as follows: The caliber of the German is .311; of the Springfield .30; the length of the German barrel (including chamber) is 29.1; of the Springfield, 32.6; the German is rifled with four grooves, making one turn in 9.45 inches; the Springfield with three grooves, one turn in 9.5 inches.

The German bullet is 1.23 inches long, weighs 226 grains, and has a smooth nickel or German silver jacket. The bullet used in the Springfield is 1.326 inches long, weighs 230 grains, and has a copper jacket with three cannelures.

The bullets being so nearly of the same weight, the rifling not greatly different, while the diameter of the Springfield barrel is less and its length considerably (three inches) in excess, it was anticipated that higher velocities for the same charges would be obtained from it than from the German gun. The trials given below showed this excess, as observed at a distance of 50 feet from the muzzle, to be between 60 and 80 feet.

The Springfield bullet being slightly heavier than the German, but

of less diameter, will better retain its velocity, provided its flight is stable, as the range increases; and that its flight is stable has been amply proved by the excellent targets lately made here at 2,000 yards.

Consequently the barrel and bullet experimentally adopted for our service will, with equal charges of powder, give a flatter trajectory and greater range than the rifle and bullet of the German army.

The comparative trials of the two barrels and bullets are given below :

Charge.	Shot.	Instrumental velocity.	
		German rifle.	Springfield caliber .30.
		Feet.	*Feet.*
36 grains.....	1	1,898	2,004
	2	1,887	2,026
	3	1,970	1,998
	4	1,946	2,048
	5	1,885	1,930
	6	1,968	1,946
	7	1,952	1,976
	8	1,966	1,938
	9	1,926	1,978
	10	1,926	1,958
	11	1,903	1,984
	12	1,920	1,980
	13	1,873	1,979
	14	1,898	1,942
	15	1,902	1,984
	16	1,887	1,978
	17	1,924	1,982
	18	1,908	1,990
	19	1,920	1,974
	20	1,913	1,965
Mean.....		1,918.6	1,978.0
Corresponding muzzle velocity.		1,956.4	2,016.7
Average variation from mean velocity		23.2	19.5
37 grains.....	1	1,938	2,044
	2	1,946	2,028
	3	1,930	2,022
	4	1,948	2,038
	5	1,948	2,056
	6	1,996	2,056
	7	1,960	2,028
	8	1,926	1,996
	9	1,952	2,030
	10	1,934	2,018
	11	1,968	1,992
	12	1,954	2,004
	13	1,936	2,016
	14	1,926	2,014

Charge.	Shot.	Instrumental velocity.	
		German rifle.	Springfield caliber .30.
		Feet.	*Feet.*
37 grains.....	15	1,898	2,002
	16	1,962	2,008
	17	1,946	2,060
	18	1,888	2,012
	19	1,966	1,998
	20	1,948	2,052
Mean.....		1,943.5	2,023.7
Corresponding muzzle velocity.		1,981.8	2,063.5
Average variation from mean velocity		17.2	17.9
38 grains.....	1	1,994	2,076
	2	1,976	2,088
	3	2,000	2,032
	4	2,034	1,992
	5	2,026	2,028
	6	1,978	2,038
	7	1,976	2,012
	8	1,976	2,022
	9	1,962	2,012
	10	1,942	2,032
	11	1,916	2,060
	12	1,956	2,060
	13	1,976	2,054
	14	1,952	2,096
	15	2,036	2,108
	16	1,986	2,100
	17	1,968	2,068
	18	1,970	2,100
	19	1,990	2,098
	20	1,950	2,052
Mean.....		1,978.2	2,056.4
Corresponding muzzle velocity.		2,017.1	2,096.5
Average variation from mean velocity.....		21.9	29.0

While for the elements mentioned the Springfield appears superior to the German, yet the latter has the advantage of a superior primer for its ammunition.

In obtaining the above record of velocities (60 shots) there were no miss-fires with the German primer, while there were 31 with Frankford Arsenal primer. In all these cases the primer was exploded by the first blow of the firing-pin, but failed to ignite the powder charge. This weakness of the primer was also apparent in the cartridges fired for pressures, 64 cartridges (34 miss-fires) being necessary to obtain the record of 30 shots given on a previous page. It was observed that as the charge was increased, more nearly filling the shell, the liability of a miss-fire was diminished; though even when the shell was filled, as it was with a charge of 38 grains, this defect was not eradicated.

In nearly all cases also, when the charge was ignited, it followed at an appreciable interval after the explosion of the primer, the "hang fire" being well marked. For every charge, regardless of its amount, ignition was prompt with the German primer. With the latter the anvil is in the shell at the bottom of the primer pocket, and on either side of it is a small flame channel. In the Frankford cartridge the anvil is in the primer, with one single central vent at the bottom of the pocket. As the space afforded for the passage of flame is greater in the single Frankford than in the two German vents combined, the superiority of the latter primer must be ascribed to differences in the composition of the priming material.

In the earlier experiments at this Armory with smokeless powders the primers of the service (caliber .45) ammunition were employed. Many failures to ignite followed, and to overcome the difficulty a stronger primer was manufactured at Frankford Arsenal. This has answered so well for the majority of powders since tested that failures to ignite which may have been experienced were ascribed to some quality of the particular powder under trial, whereas from these tests it would appear as if a portion at least of the responsibility for failures might possibly have been properly charged to the primer.

The necessity of still stronger primers than those now made at Frankford for use with smokeless powders is therefore evident. In obtaining the above record the powder was taken from store having been exposed to only the ordinary changes of atmosphere found in a room heated during the daytime to about 70° and slightly cooling at night. To determine the effect of moisture, of heat, and of cold, one lot (about 3 ounces) was continuously exposed for forty-eight hours in an atmosphere rendered moist by escaping steam; another lot was exposed for four days to a dry heat, which, during eight hours each day, was in the vicinity of 150° or 160°, and for the remainder of each twenty-four hours between that point and 90°; and a third lot was continuously exposed for ten days to a temperature of about 10° or 15°. As the times of exposure expired cartridges were at once loaded from each lot and fired in the Springfield pressure barrel and in the German magazine rifle, with the following results:

EXPOSED TO MOISTURE.

Charge.	Pressure barrel, caliber .30.			German rifle.	
	Shots.	Pressure.	Instrumental velocity.	Shots.	Instrumental velocity.
		Pounds.	*Feet.*		*Feet.*
36 grains	1	52,200	1,887	1	1,811
	2	43,800	1,797	2	1,800
	3	56,900	1,890	3	1,825
	4	46,600	1,845	4	1,810
	5	51,200	1,888	5	1,766
	6	50,400	1,860	6	1,806
	7	52,900	1,811	7	1,806
	8	55,400	1,910	8	1,797
	9	59,800	1,852	9	1,805
	10	51,200	1,868	10	1,845
Mean		52,040	1,860.8	.....	1,807.1
Corresponding muzzle velocity		.....	1,897.4	.....	1,842.6
Average variation from mean		3,400	27.8	.....	12.5

EXPOSED TO HEAT.

Charge.	Pressure barrel, caliber .30.			German rifle.	
	Shots.	Pressure.	Instrumental velocity.	Shots.	Instrumental.
		Pounds.	*Feet.*		*Feet.*
36 grains	1	73,400	2,050	1	1,992
	2	70,000	2,050	2	1,996
	3	68,300	2,028	3	2,010
	4	74,200	2,058	4	2,004
	5	68,800	2,012	5	2,024
	6	68,300	2,004	6	2,000
	7	68,800	2,014	7	2,008
	8	71,000	2,024	8	1,994
	9	63,200	2,020	9	2,008
	10	71,000	2,014	10	1,988
Mean		69,700	2,027.4	.....	2,002.4
Corresponding muzzle velocity		.....	2,067.2	.....	2,041.7
Average variation from mean		2,220	15.3	.....	8.4

EXPOSED TO COLD.

36 grains	1	37,200	1,797	1	1,770
	2	32,700	1,781	2	1,808
	3	36,800	1,803	3	1,777
	4	38,300	1,783	4	1,797
	5	35,100	1,835	5	1,781
	6	42,800	1,843	6	1,777
	7	43,300	1,831	7	1,808
	8	36,200	1,790	8	1,764
	9	.....	.....	9	1,7 0
	10	.....	.....	10	1,802
Mean		37,800	1,807.9	.....	1,786.4
Corresponding muzzle velocity		.....	1,843.5	.....	1,825.4
Average variation from mean		2,750	21.4	.....	13.9

Comparing these tables with the results of the firing under normal conditions, it will be observed that the effect of moisture was just perceptible in the pressure, but that it caused a loss of 80 or more feet in the velocity. When exposed to cold (the powder was probably also affected by the attendant moisture) the decrease in both pressure and velocity was very marked. Heat produced an excessive increase in pressure, with a considerable gain in velocity.

In these latter firings the German primer, in all cases, promptly ignited the charge. There were no failures with the Frankford primer with the powder that had been subjected to heat; but with the powder exposed to moisture there were fourteen (in the effort to obtain record of ten shots), and sixteen failures (in obtaining eight records) with the powder exposed to cold.

In the execution of much of the firing in this report I was assisted by Lieut. F. P. Peck, Ordnance Department.

Respectfully submitted.

S. E. BLUNT,
Capt., Ord. Dept., U. S. Army.

Col. A. R. BUFFINGTON,
Commanding.

(6–'92.)

No. 4.

SECOND REPORT ON TROISDORF SMOKELESS POWDER.

SPRINGFIELD ARMORY, *April 1, 1892.*

SIR: On December 30, 1891, I submitted to the commanding officer of the Armory a report on some Troisdorf smokeless powder, which had been procured by the United States military attaché at Vienna, Austria, from the Rheinisch-Westphälische Sprengstoff Geselschaft, and had been here tested for velocities and pressures in the caliber .30 Springfield pressure barrel and in the Springfield rifle caliber .30 (No. 2), lately before the Board on Magazine Arms.

Since that date comparative trials of the cutter and crusher methods of obtaining a record of the pressure of the powder gas in the chamber of the rifle have been concluded, and, as expressed in a report of March 31, 1892, the deduction drawn therefrom that the indications given by the crusher are the more reliable.

A table was given in that report for passing from cutter indications to what may be regarded as the actual pressures; applying that table to the pressures as recorded in the report of December 30, 1891, upon the Troisdorf powder, the velocities and pressures given by different charges should then be reported as follows:

Troisdorf smokeless powder.

Charge.	Shots, mean of.	Instrumental velocity.	Pressure indicated by cutter.	True or crusher pressure.
		Feet.	*Pounds.*	*Pounds.*
36 grains.....	10	1,937.6	53,130	35,260
37 grains.....	10	1,981.4	58,220	38,050
38 grains.....	10	2,001.3	60,360	39,190

The charges fired, 36 to 38 grains, would then appear to have actually produced pressures between 35,000 and 39,000 pounds per square inch.

Very respectfully, your obedient servant,

S. E. BLUNT,
Capt., Ord. Dept., U. S. Army.

Col. A. MORDECAI,
Commanding Springfield Armory.

(2370–'92.)

APPENDIX 15.

REPORT OF A BOARD OF OFFICERS ON CALIBER .38 SMITH & WESSON AND COLT REVOLVERS, CONVENED BY THE FOLLOWING INDORSEMENT ON LETTER FROM ORDNANCE OFFICE, DATED NOVEMBER 5, 1891.

[First indorsement.]

SPRINGFIELD ARMORY,
Springfield, Mass., November 28, 1891.

Respectfully referred to a board, to consist of Capt. S. E. Blount and Lieut. F. P. Peck, for examination, report, and recommendations. Reports of officers referred to within accompany this paper, and they will be examined in connection with the respective lots of revolvers, which have been kept separate, as received.

A. R. BUFFINGTON,
Colonel, Ord. Dept., Commanding.

SPRINGFIELD ARMORY,
Springfield, Mass., January 16, 1892.

The board met on November 28, 1891, and at such subsequent times as necessary for the prosecution of the duty devolved upon it.

Present, both the members.

The arms submitted for examination comprised 94 of each of the caliber .38, double action, Colt and Smith & Wesson revolvers.

The revolvers had, about fourteen months previously, been issued for trial in the hands of troops, and were now accompanied by the reports of the company commanders by whose men they had been used.

From an examination and analysis of these reports it is evident that certain advantages and disadvantages have been developed in both revolvers, which, summarizing the opinions as there expressed, may be stated as follows:

COMMENTS AND OPINIONS OF CAVALRY OFFICERS.

Smith & Wesson.

[Double acting, five-chambered; weight, 1 pound 4 ounces.]

Advantages.—To cock and discharge the arm requires a pull on the trigger and a simultaneous pressure on the safety device by the ball of the thumb; accidental discharge is thus prevented in the most assured manner. The action of the cylinder is excellent, always being locked except when revolved by pressure on the trigger; it becomes again locked just before discharge, thus securing accurate centering of the cartridge and preventing miss-fires and keyholing of the bullet.

The click of the lock when the trigger is pulled nearly back, indicating when the discharge may be expected, assists to secure accurate aim at that instant. The extractor is automatic when opened for loading, and loading is then simply and easily accomplished.

The revolver is comparatively light and small, so that it may be carried conveniently and with little discomfort. Its fire is sufficiently accurate for the ranges at which it would be employed.

Disadvantages.—It contains 53 component parts and is quite delicate and liable to get out of order. It can only be cocked by pulling the trigger, since it has no hammer, properly speaking (it therefore does not admit of single-action fire), and consequently should the double action get out of order the arm would be completely disabled. The safety device necessitates the use of two sets of muscles to effect a discharge and adds materially to the complication of the mechanism, while it is not deemed an essential feature of a military arm. The weight is poorly distributed for steady aim; it is too light, the shock of discharge being quite severe upon the hand in continued firing. The trigger guard is too small, scarcely permitting the entrance of the forefinger of the average sized hand. The handle is too small and not suited to the hand. The drag of the trigger is long, heavy, and uneven. It is often difficult and sometimes impossible to open for extraction and reloading—a condition often induced by a small amount of rust or dust. It is more liable to get out of order from rust or dust than the Colt, and, having the double action only, this condition can not be remedied except by cleaning.

Colt.

[Double and single acting, six chambered; weight, 2 pounds ¼ ounce.]

Advantages.—It is more simple and substantial in construction than the Smith & Wesson, containing 10 less component parts. It is double acting, like the Smith & Wesson, and has the decided advantage that it may also be used as single acting if desirable or if made necessary through failure of the double action to operate.

While not so light as the Smith & Wesson, it is still conveniently carried and its weight is sufficient to prevent so severe a shock to the hand in firing. The weight is well distributed for steady aim. The trigger guard and handle are large enough and well suited to the hand. The drag of the trigger is very smooth, comparatively light, and short.

There being one more chamber than in the Smith & Wesson, the arm, other things being equal, is one-fifth more effective. It is never difficult to operate for extraction or reloading. The extractor is positive in its action and works equally as well as the Smith & Wesson. The revolver is sufficiently safe, an accidental discharge rarely occurring. It gives an initial velocity of 723 feet with a 150-grain bullet, as compared with 635 feet with the 146-grain bullet of the Smith & Wesson, and has greater penetration at all ranges; using a slightly heavier bullet it therefore has greater stopping power than the Smith & Wesson.

Its accuracy with a fixed rest is about the same as that of the Smith & Wesson, but in the hands of troops it appears upon the whole to have done better shooting.

Disadvantages.—At "safety" the cylinder moves freely, and therefore may be inadvertently turned when replacing the revolver in or withdrawing from the holster; consequently, if one or more chambers are empty it may have to be snapped several times before obtaining a dis-

charge. Even when the trigger is being pulled the cylinder is not held perfectly secure, thus producing, in some instances, miss-fires from inaccurate centering of the cartridge or, if the arm is discharged, occasionally causing keyholing of the bullet. The rebound spring sometimes fails to return the trigger to its normal position and the hammer to "safety" after firing, but this occurs very rarely and, when it does, may be remedied by a slight pressure by the forefinger upon the trigger, or by using the hammer.

COMMENTS AND OPINIONS OF THE BOARD.

Previous to the issuing of these revolvers to the cavalry the types were very thoroughly tested at this Armory by a board whose report appears in Appendix 12, Report Chief of Ordnance for 1889.

Of the thirteen cavalry officers to whom these revolvers were then submitted for competitive trial in the hands of troops, whose reports, covering an experience of over a year, have been summarized above, eleven express an unqualified preference for the .38 caliber Colt, one for the .38 caliber Smith & Wesson, while one, favoring the .38 caliber Colt above the .38 caliber Smith & Wesson, prefers to either of the smaller calibers the present .45 caliber Colt on account of its heavier bullet, and consequent greater stopping power.

The entire tests thus appearing so exhaustive, it was deemed superfluous by the board to make any further competitive trials. The board made, however, a careful examination of all the revolvers to determine to what extent their serviceability had been impaired, if at all, having especial regard to the characteristic features of each weapon and to those points wherein, according to the reports, any weakness or imperfection had been developed; and to this end a sufficient number of rounds was fired in each of the 188 revolvers to exhibit their action.

The revolvers as received at this Armory were in various stages of rust and dirt, due apparently in many cases to their not having been cleaned after the final firing; in others to their not having been oiled after cleaning, and to the consequent effect of the atmosphere. But two lots were found in proper condition.

They were all tested in the condition received.

Of the ninety-four Smith & Wesson so tested seven were unserviceable and could not be fired; of these seven, as was afterwards shown by dismounting and cleaning, the main springs of two were broken and the remaining five failed through the effect of rust about the cylinder or the safety device. Three others, while not unserviceable, were worked with much difficulty, and that only after having been manipulated for some minutes.

Of the ninety-four Colts so tested but one was found unserviceable, due to rust on the cylinder. Of the others, the rebound spring in one worked poorly and in two the cylinder was revolved at first with difficulty. Miss-fires occurred with five on account of inaccurate centering of the cartridge; on second trial this inaccurate centering was not repeated and discharge followed.

Inasmuch as the two types had been equally exposed, this firing made apparent the greater ability of the Colt to withstand hard usage and demonstrated the value of its single action, whereby greater power may be applied to cock the arm and revolve the cylinder when the weapon is clogged by rust or dust.

With the reports from the field the board entirely concurs as to the

disadvantages of the Smith & Wesson as previously summarized. As to its advantages, the board dissents from the favorable opinion, advanced by one officer, with regard to the safety device, they deeming such a device not merely unessential in a military arm but decidedly objectionable. As to the "click" of the lock of the Smith & Wesson, and the presumed advantage thereby derived from its indication of approaching discharge, the board is of the opinion it would only be used when firing, dismounted, slowly and with deliberate aim. Under such circumstances only single shots would be fired (if repeated, only after some interval), and for such a purpose the single action of the Colt answers much better than the double action of the Smith & Wesson. The board considers the locking of the cylinder in the Smith & Wesson superior to that in the Colt.

With regard to the Colt, the board concurs with the field reports previously summarized, both as regards the advantages and disadvantages there specified, the only important one of the latter being the insecure locking of the cylinder at the time of firing and the fact that it is not locked at the position of "safety."

To sum up the conclusions of the board, it might then be said that they consider the two revolvers as practically equal in the matter of sights, loading, and ejection and accuracy of fire; that in the cylinder action the Smith & Wesson is much the better; but that in all other essential features the comparison is decidedly in favor of the Colt; and that finally, therefore, the double-action Colt caliber .38 is, upon the whole, far superior to the double-action Smith & Wesson caliber .38 for military purposes.

Between the .38 caliber Colt and the .45 caliber Colt now in service the preference, in the opinion of the board, should be awarded to the former, on account, principally, of its less weight and size, its greater ease and rapidity of ejection and loading, its greater accuracy, and, above all, its adaptability for use as either a single or double action revolver, and its full equality with the present service arm in all other essential features.

To the latter statement but one exception can be advanced—its diminished "stopping power" as compared with the larger revolver. That the stopping power is less is of course evident, but that is no material disadvantage if it still remains sufficient. The question can only be definitely settled by actual trial against living objects, and until the revolver is tested in action the opinions of the cavalry officers who have used the weapons afford the best available evidence. All of these, with one exception, who have referred to the subject, express a preference for the .38 caliber above the .45 caliber. Accepting, then, their judgment in this matter, on account of the superiority of the arm in other respects, and in accordance with its instructions to make recommendation, the board recommends the adoption of the Colt double action, caliber .38, in place of the caliber .45 now in service.

If this recommendation is approved and carried into effect the board further recommends the following modifications of the revolver:

The substitution for the present rebound spring of one slightly stronger.

Such change in the cylinder action as will prevent its free rotation while the hammer is at "safety," but which more particularly will securely lock it when the arm is fired.

The rounding of the present sharp edge of the frame, especially of that portion on the right-hand side near the wooden stock.

There being no further business before it, the board, on January 16, 1892, adjourned *sine die.*

S. E. BLUNT,
Capt., Ord. Dept., U. S. Army.
FREMONT P. PECK,
Lieut., Ord. Dept., U. S. Army.

Approved. Itis understood that the small caliber Colt has been improved in several respects since the purchase of these revolvers.

A. R. BUFFINGTON,
Colonel, Ordnance Department.

SUPPLEMENTAL REPORT OF THE BOARD CONSTITUTED BY THE FIRST INDORSEMENT ON ORDNANCE OFFICE No. 370, AND RECONVENED BY THE FOLLOWING INDORSEMENT ON THE SAME LETTER:

[Fifth indorsement.]

SPRINGFIELD ARMORY,
Springfield, Mass., February 29, 1892.

Respectfully returned to the board constituted by the first indorsement hereon with the revolver referred to in fourth indorsement, and with instructions to the board to subject the revolver to a thorough test and to submit to this office a report thereon, with any recommendations the board may have to make resulting from the test.

A. MORDECAI,
Col., Ord. Dept., U. S. Army, Commanding.

SPRINGFIELD ARMORY, MASS.,
March 23, 1892.

The board met on March 1 and at such subsequent times as necessary for its work.

Present, both the members.

The revolver submitted to the board for test is the same as the double-acting .38 caliber Colt referred to in its report of January 16, 1892, but with the modifications recommended by the board, *i. e.*—

The substitution for the present rebound spring of one slightly stronger. Such change in the cylinder action as will prevent its free rotation while the hammer is at "safety," but which, more particularly, will securely lock it when the arm is fired.

The rounding of the present sharp edge of the frame, especially of that portion on the right-hand side near the wooden stock.

These modifications have been brought about by the addition of two more component parts—the *cylinder lock* and *cylinder-lock spring*—the continuation of a portion of the upper edge of the trigger blade to form a stud or *cylinder stop* a little in rear of the trigger pin, the rounding off of the edge of the frame, and the strengthening of the rebound spring as above mentioned.

Referring to Appendix 12, Report of the Chief of Ordnance for 1889, description of the former model of this revolver, the board desires to call attention to the "nomenclature of component parts," which it believes should be slightly corrected.

There is but one stock screw; the word "spring" should be stricken out after 34; and there should be added: "40. Hand-spring bearing-pin"—a pin projecting from the frame cap to afford a bearing for the hand spring.

This, however, leaves the total number of component parts (43) of that model unchanged.

The nomenclature of component parts for the revolver now submitted to the board will then be as above, with the addition of the following: 41. Cylinder lock, and 42. Cylinder lock spring, thus making the total number of component parts for this new model 45.

The "operation of the parts," as given in that report, applies without change to the new revolver, but the following should be added:

The cylinder lock is a small, flat, irregularly-shaped piece of metal pivoted on the trigger pin on the right of the trigger blade; its forward end forms a nose, which, in its normal position, projects upward through an opening in the frame and engages in one of the six rectangular notches cut in the circumference of the cylinder just forward of the trigger.

A spring, dovetailed into its lower edge and bearing against the under side of the arm of the rebound lever, constantly urges the nose towards this upward position, so that the cylinder is firmly locked against motion in either direction while the trigger is forward.

The rear end of the cylinder lock is cut away on a vertical semicircle, partially embracing the end of the rebound lever arm, and furnishing thus a bearing for the latter when in operation.

When the trigger is pulled back the end of this arm, bearing upward against the rear end of the cylinder lock, withdraws the nose from engagement in the notch, so that the cylinder is left free to move under the action of the hand. At the same time the stud on the upper side of the trigger blade (the *cylinder stop*), being in rear of the pivot, begins to move upward through the frame and enters by degrees one of another series of six notches in the cylinder near its base. These notches are cut away on the advance side to permit the gradual entrance of the cylinder stop, but have square shoulders on the opposite side, so that the cylinder is stopped at the proper time and prevented from turning further.

The cylinder is thus more securely locked at the instant of firing than with the former model. After discharge, and when the trigger moves forward, the cylinder stop is withdrawn from its notch, and the nose of the cylinder lock, under the action of its spring, recovers its normal position by engaging in one of the rectangular notches and securely locks the cylinder until the trigger is again pulled.

The revolver was tested by firing it with both the double and single action as follows:

Seven hundred rounds, double action, cleaned after every 50; 150 rounds, single action, cleaned after every 50; 100 rounds, double action, without cleaning; 200 rounds, double action, without cleaning; 200 rounds, single action, without cleaning. Or, a total of 1,000 rounds, double action, and 350 single action.

In the early part of the firing it was found that after 40 to 45 shots sufficient fouling had accumulated about the cylinder and its bearings to cause it to work with some difficulty when used as double acting, making cleaning necessary after each 50. This difficulty could always be easily overcome by using the single action.

After having been fired 850 rounds, however, it seemed to work with greater freedom, so that first 100 and then 200 rounds were fired without difficulty, using the double action.

Not a single failure to discharge occurred during the entire firing.

The primers of each charge were carefully examined before ejecting, and all showed that they had been struck centrally, but the accurate centering of the cartridge was still more conclusively proved by the fact that no keyholing occurred with any of the 1,350 bullets fired.

There was no failure of the rebound spring to return the trigger and hammer to their proper positions at "safety," and the frame no longer hurt the hand in continued firing.

The severe firing test which the revolver thus successfully withstood without the development of a single defect of any sort was sufficient to satisfy the board that those features wherein they had recommended modifications had been satisfactorily corrected, and further firing was discontinued.

It was then dismounted to observe the condition of its mechanism. The teeth of the ratchet were slightly worn; the rear shoulders of the stop notches were slightly upset, and the bore of the barrel near its junction with the cylinder was somewhat scored; still, none of these effects were material and every part was in a perfectly serviceable condition.

Inasmuch as the mechanical changes had been so slight, and the ballistic properties of this revolver remained unchanged since the original tests, and for the reasons given in their former report, the board deemed it unnecessary to subject it to any further tests.

In conclusion, the board would repeat their favorable impressions of this revolver as previously expressed, and would add that all material objections have been successfully overcome.

In accordance, therefore, with its instructions to make recommendations, the board recommends the adoption of the Colt double (and single) action, caliber .38, revolver as now modified, in place of the caliber .45 Colt now in service; and that if this recommendation is approved and carried into effect the one now in the hands of the board be taken for a model.

There being no further business before it, the board, March 23, 1892, adjourned *sine die*.

S. E. BLUNT,
Captain, Ordnance Department.
FREMONT P. PECK,
Lieutenant, Ordnance Department.

Col. A. R. BUFFINGTON,
Commanding.

SPRINGFIELD ARMORY,
March 25, 1892.

Proceedings and test approved.

A. MORDECAI,
Colonel, Ord. Dept., Commanding.

(370–'92.)

APPENDIX 16.

THE EFFECT OF GRANULATION ON VELOCITIES AND PRESSURES OF WETTEREN SMOKELESS POWDER.

(2 plates.)

FRANKFORD ARSENAL,
Philadelphia, Pa., September 22, 1892.

SIR: I have the honor to submit a report of experiments made by your direction on the following subjects:

(1) THE EFFECT UPON VELOCITY, DUE TO VARIATIONS OF GRANULATION, OF THE WETTEREN SMOKELESS POWDER.

That the velocity and pressure obtained with a powder are largely dependent on the size of grain, and that irregularity of grain causes great variations in velocities and pressures, are well-known facts. The granulation of the Wetteren powder is extremely irregular. It was therefore proposed to lessen this irregularity as much as possible by sieving through a series of sieves, noting the improvement in uniformity of velocity resulting. A previous experiment in this direction is given on page 174, Report Chief of Ordnance, 1891. The difficulty at that time of procuring suitable sieves prevented more extended experiment. The sieves now on hand have meshes respectively of .10, .09, .08, .07, and .06 inches.

By sieving successively, it was found that most of the grains passed through the .10 and .09 inch sieves, and that most of them would not pass through the .08 and .07 inch sieves. The latter granulations were designated as + .08 inch and +.07 inch, and the grains which would not pass through the .06-inch sieve were designated as + .06 inch. These last three types were selected for experiment.

(2) MACHINE LOADING AS AFFECTED BY SIEVED WETTEREN POWDER.

Machine loading of the Wetteren powder was suspended here after somewhat extended experiment. (See page 173, Report Chief of Ordnance, 1891.) It was thought by you that with powder of a more regular granulation machine loading might be more successful, and accordingly experiments were prosecuted as directed with the three types of granulation above selected, using results obtained at the same time with unsieved Wetteren powder as a standard of comparisons. The two series of experiments (on granulation and on machine loading) were carried on in conjunction.

The velocities at 53 feet from the muzzle recorded are the mean of the results given by two chronographs. The firing was done in series of ten shots (using series of hand-loaded and machine-loaded cartridges, alternately, and the gun was cleaned after each series). Experimental .30 caliber Springfield Rifle A, received September 5, 1892, was used for the firing. The 36-grain charge and standard bullet were used.

PRELIMINARY EXPERIMENTS.

September 6, 1892.

[Barometer, 30.07″. Thermometer, dry bulb, 73°; wet bulb, 60°. Velocity at 53 feet from muzzle.]

+.08 WETTEREN POWDER.

Character of loading.	Mean of 10 shots.	Extreme variation.	Mean variation.
	Ft. secs.	*Ft. secs.*	*Ft. secs.*
Hand	1,849	48	12.9
Machine	1,876	72	14.9

+.07 WETTEREN POWDER.

Hand	1,924	62	14.5
Machine	1,955	66	11.4

+.06 WETTEREN POWDER.

Hand	2,015	59	15.3
Machine	2,051	44	11.1

September 8, 1892.

[Barometer 30.37″. Thermometer, dry bulb, 72°; wet bulb, 65°. Velocity at 53 feet from muzzle.]

+.08 WETTEREN POWDER.

Character of loading.	Mean of 10 shots.	Extreme variation.	Mean variation.
	Ft. secs.	*Ft. secs.*	*Ft. secs.*
Hand	1,815	51	17.5
Machine	1,833	49	10.6

+.07 WETTEREN POWDER.

Hand	1,899	36	8.3
Machine	1,904	53	12.5

+.06 WETTEREN POWDER.

Hand	2,000	37	8
Machine	2,035	40	11.3

September 12, 1892.

[Barometer, 30.13″. Thermometer, dry bulb, 77°; wet bulb, 67°. Velocity at 53 feet from muzzle.]

UNSIEVED WETTEREN POWDER.

Character of loading.	Mean of 10 shots.	Extreme variation.	Mean variation.
	Ft. secs.	*Ft. secs.*	*Ft. secs.*
Hand	1,816	111	30.4
Machine	1,857	98	24.4
Hand	1,826	56	11.4
Machine	1,861	73	23.6

These preliminary experiments showed a great improvement as to uniformity of velocity with the machine-loaded ammunition, the results being as good as when hand loading was employed.

As directed, the experiments were further continued, using unsieved powder and +.07 powder, for comparison. The latter granulation was selected as the most suitable one to be compared with the unsieved powder, as it is a granulation which constitutes the largest proportion of the bulk of Wetteren powder.

September 15.

[Barometer, 29.98″. Thermometer, dry bulb, 69°; wet bulb, 61°. Velocity at 53 feet from muzzle.]

+.07 POWDER.

Character of loading.	Mean of 50 shots.	Extreme variation.	Mean variation.
	Ft. secs.	*Ft. secs.*	*Ft. secs.*
Hand	1,884	153	14.16
Machine	1,892	127	19.8

UNSIEVED POWDER.

Hand	1,857	139	21.36
Machine	1,836	228	27.2

September 23.

[Barometer, 30.27″. Thermometer, dry bulb, 78°; wet bulb, 74°. Velocity at 53 feet from muzzle.]

+.07 POWDER.

	1,941	98	20.20

Summary showing the effect of variations of granulation on velocity.

UNSIEVED POWDER.

Character of loading.	No. of shots.	Mean velocity at 53 feet from muzzle.
		Ft. secs.
Hand	10	1,816
Do	10	1,826
Do	50	1,857
Machine	10	1,857
Do	10	1,861
Do	50	1,836

+.08 POWDER.

Hand	10	1,849
Do	10	1,815
Machine	10	1,876
Do	10	1,833

Summary showing the effect of variations of granulation on velocity—Continued.

+.07 POWDER.

Character of loading.	No. of shots.	Mean velocity at 53 feet from muzzle.
		Ft. secs.
Hand	10	1,924
Do	10	1,899
Do	50	1,884
Machine	10	1,955
Do	10	1,904
Do	50	1,892
Do	50	1,941

+.06 POWDER.

Hand	10	2,015
Do	10	2,000
Machine	10	2,051
Do	10	2,035

The +.08 powder shows little improvement in velocity over the unsieved, but the +.07 and +.06 give a decided increase of velocity.

Summary showing the effect of granulation on uniformity of velocity.

UNSIEVED POWDER.

Character of loading.	No. of shots.	Mean variation in velocity.
		Ft. secs.
Hand	10	30.4
Do	10	11.4
Do	50	21.36
Machine	10	24.4
Do	10	23.6
Do	50	27.2

+.08 POWDER.

Hand	10	12.9
Do	10	17.5
Machine	10	14.9
Do	10	10.6

+.07 POWDER.

Hand	10	14.5
Do	10	8.3
Do	50	14.16
Machine	10	11.4
Do	10	12.5
Do	50	19.8
Do	50	20.2

+.06 POWDER.

Hand	10	15.3
Do	10	8.
Machine	10	11.1
Do	10	11.3

This summary shows that the sieved powder gives a much more uniform velocity than the unsieved, though which is the most favorable sieving in this regard is not so apparent.

This summary also gives a comparison of hand and machine loading as regards uniformity of velocity produced.

The decided superiority of hand loading over machine loading, which led to the suspension of the latter method in 1891, is not here shown, though when the mean of as large number of shots as 50 is taken the hand loading is still shown to give the best results. It is hoped that improvements now being made in the loading machine may again put the two methods on an equality.

Respectfully, etc.,

J. W. BENÉT,
Lieut., Ord. Dept., in charge Ballistic Division.

The COMMANDING OFFICER FRANKFORD ARSENAL.

FRANKFORD ARSENAL,
Philadelphia, Pa., September 22, 1892.

SIR: I have the honor to state that it is known at this arsenal that the variations of velocity and pressure due to the use of the Wetteren powder with the .30-inch caliber experimental rifle is largely attributable to irregular granulation of the powder.

It was for the purpose of ascertaining the degree of variation that the following examination was made.

The powder was obtained from Coöpale & Cie, Belgium, through E. I. DuPont & Co., and was received at this arsenal April 7, 1891.

I procured a set of five sieves with circular holes, those in the upper one having a diameter of .10 inch and those of each succeeding one decreasing by .01 inch, thus giving a range from .10 to .06 inch.

The powder that remained on or did not pass through any one sieve of the series was designated + (as + .08); that passing through the lowest sieve — .06.

Three lots, weighing respectively 3,000, 3,000, and 29,264 grains, were examined. The first lot was from a can in use at the proof house; the second and third from the magazine, where it had been stored in a closed vessel.

The following table shows the percentage of each granulation from + .10 to — .06, resulting from passing the powder through the various sieves:

	I.	II.	III.
—.06	2.73	2.96	2.28
+.06	20.57	23.40	13.59
+.07	43.70	39.84	30.56
+.08	25.20	28.23	30.22
+.09	6.53	5.17	19.32
+.10	1.27	.40	4.04

A number of irregular pieces were taken from + .10 of lot III, an enlarged photograph, marked 1, of which is herewith; photographs, enlarged, marked 2 and 3, also show the appearance of the powder before sifting, marked 2, and that of the + .07 after sifting, marked 3.

Caliber .30 cartridge shells were loaded with weighed charges of 36 grains of the various siftings, and fired from the wall pressure rifle, caliber .30, until this arm became disabled, after which from the end pressure rifle, and those from the third lot from the experimental Springfield rifle. The end pressure rifle generally gives higher velocities than the wall pressure rifle, which accounts for certain records in this table.

LOT I.

Size of powder.	No. of shot.	Average pressure square inch.	Average instrumental velocity 53 feet.	Mean variation velocity.	Extreme variation velocity.
WALL PRESSURE RIFLE.		*Pounds.*			
+.10	1	31,500	not taken		
+.09	5	33,338	1,631	20.1	88
+.08	5	33,306	1,692	14.3	55
+.07	5	43,416	1,801	53	203
+.06	4	57,486	1,897	20	65
—.06	2	74,940	2,015	5	10

LOT II.

END PRESSURE RIFLE.					
+.09	4	.....	1,695	3.5	10
+.08	10	.....	1,763	10.2	31
+.07	9	.....	1,907	32.	107
+.07	10	.....	1,906	2.1	9
+.06	5	.....	2,052	16.	54
WALL PRESSURE RIFLE.					
+.06	5	52,214	1,955	9.8	46
—.06	2	65,505	2,014	7.	28

LOT III.

RIFLE CALIBER,.30.					
+.08	10	.....	1,849	12.5	47
	10	.....	1,876	15.1	72
	10	.....	1,815	17.	51
+.07	50	.....	1,884	14.16	153
	10	.....	1,889	16.5	60
	10	.....	1,882	12.2	65
	10	.....	1,888	11.	47
+.06	10	.....	2,015	15.3	60
	10	.....	2,051	11.1	42
	10	.....	2,000	7.6	37

From the results shown in the table it is to be seen that for any given lot of Wetteren smokeless powder the granulation is so irregular that when it is sifted with care the variations in velocities and pressures are very marked between the different siftings.

It is known that such is not the case with black powder of any one lot, and hence these experiments, although only on a limited scale, show conclusively that the variations usually noted in velocities and pressures with the Wetteren powder unsifted must be largely due to a lack of uniformity in the grain.

The irregularity, however, or variations in the results as shown by these experiments, even with the sifted powder, point clearly to other causes not yet determined for the variations observed.

Attention is called to the fact that in some cases very uniform results

were obtained. Also that an extreme variation obtained from a small number of shots is apt to lead to unreliable conclusions. This is shown in + .07, first lot, when the average velocity of the first, third, fourth, and fifth shots was 1,769 feet with an extreme variation of 60 feet, whereas the velocity of the second shot was 1,934 feet, thus giving for the series of 5 shots an extreme variation of 203 feet.

It is also to be noted that the percentage of the various sized grains varies even for different lots taken from the same can.

Very respectfully, your obedient servant,

J. PITMAN,
Captain of Ordnance.

The COMMANDING OFFICER FRANKFORD ARSENAL.

Respectfully forwarded to the Chief of Ordnance, U. S. Army.

As the reports of Capt. John Pitman and Lieut. J. W. Benét, of this date, bear upon the same subject—that is, the granulation of Wetteren smokeless powder and its effects—they are submitted jointly.

I would further state in this connection that the Belgian Mauser cartridge is found to contain 41 grains of Wetteren smokeless powder.

The grain of the powder taken from the Mauser cartridge is far more uniform than the unsieved Wetteren powder furnished the Ordnance Department and used at this arsenal in making up experimental cartridges for the Board on Magazine Guns.

As much as 96 per cent of the Mauser cartridges range in point of granulation between +.06 and +.08; whereas not more than 75 per cent to 80 per cent of the Wetteren powder used at this arsenal ranges between these same limits.

Taking all things into consideration, the Wetteren powder promises fairly well when sieved, and when all outside of the +.06 and +.08 grain limit is excluded from a cartridge 2,026 feet seconds is obtained with the 230 grain .30-inch caliber bullet for a charge of 37.5 grains of this powder, the mean variation not exceeding 15 feet seconds.

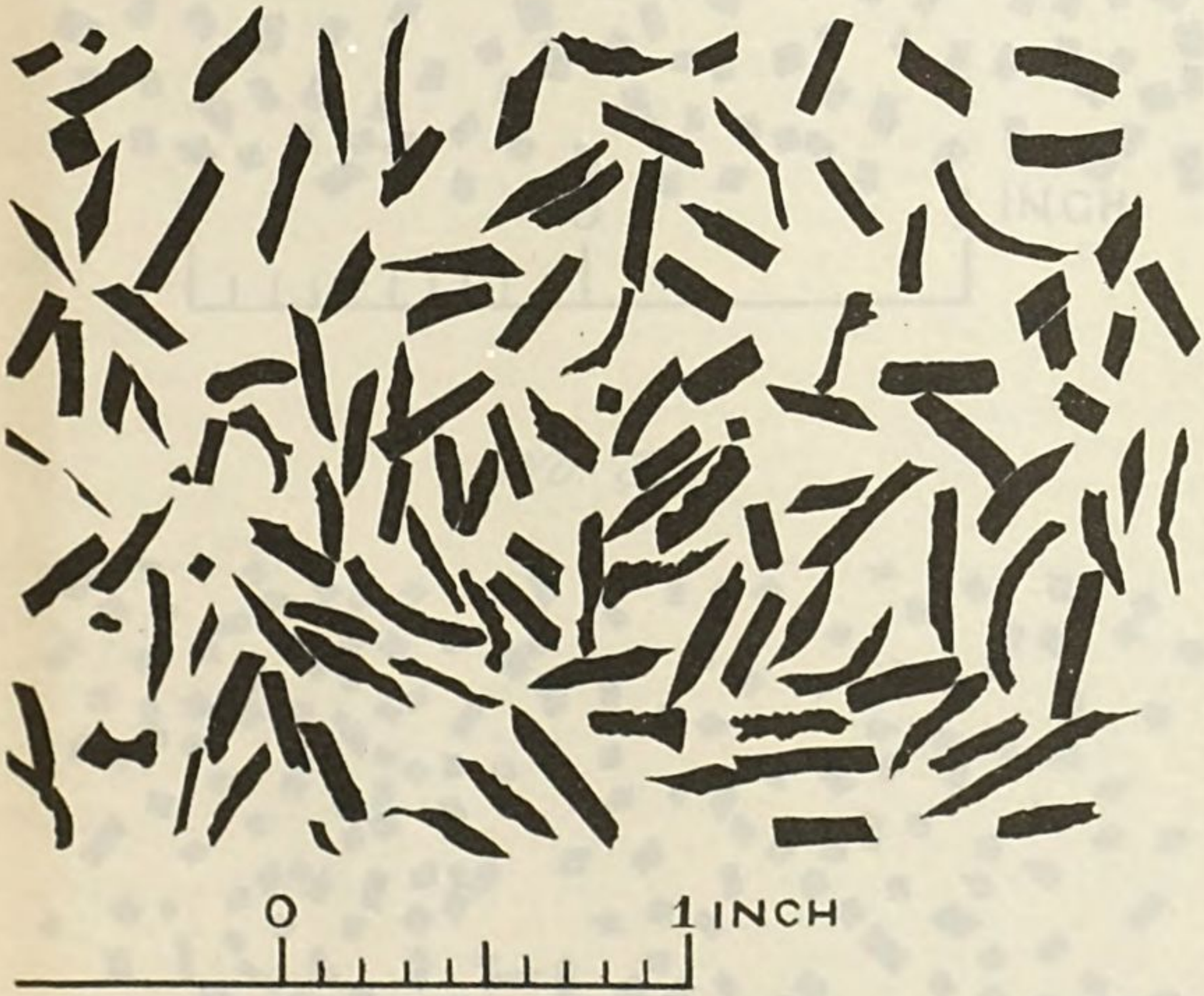
Experiments now being conducted at this arsenal with the Troisdorf smokeless powder, whilst indicating good ballistic results, are attended with much difficulty in igniting the powder in the cartridge. Numerous primers, varying both in the nature of composition and form of anvil, have been tested, but with results far from satisfactory.

Miss-fires range between 5 per cent and 59 per cent, and hang-fires between 37 per cent and 94 per cent, but efforts are still being made to overcome this defect in an otherwise good smokeless powder.

J. P. FARLEY,
Lieut. Col., Ord. Dept., Commanding.

(5012–'92.)

No. 1.



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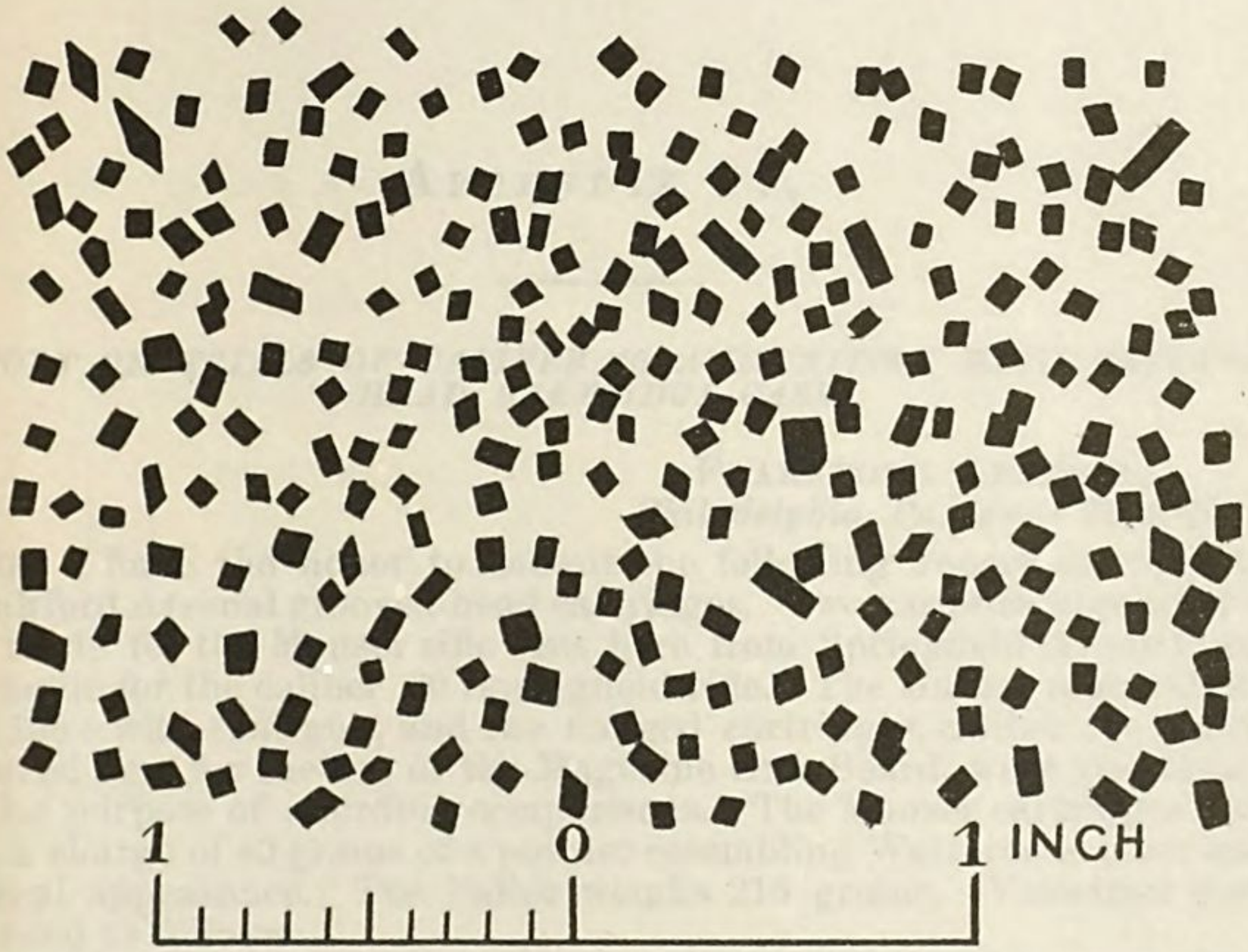

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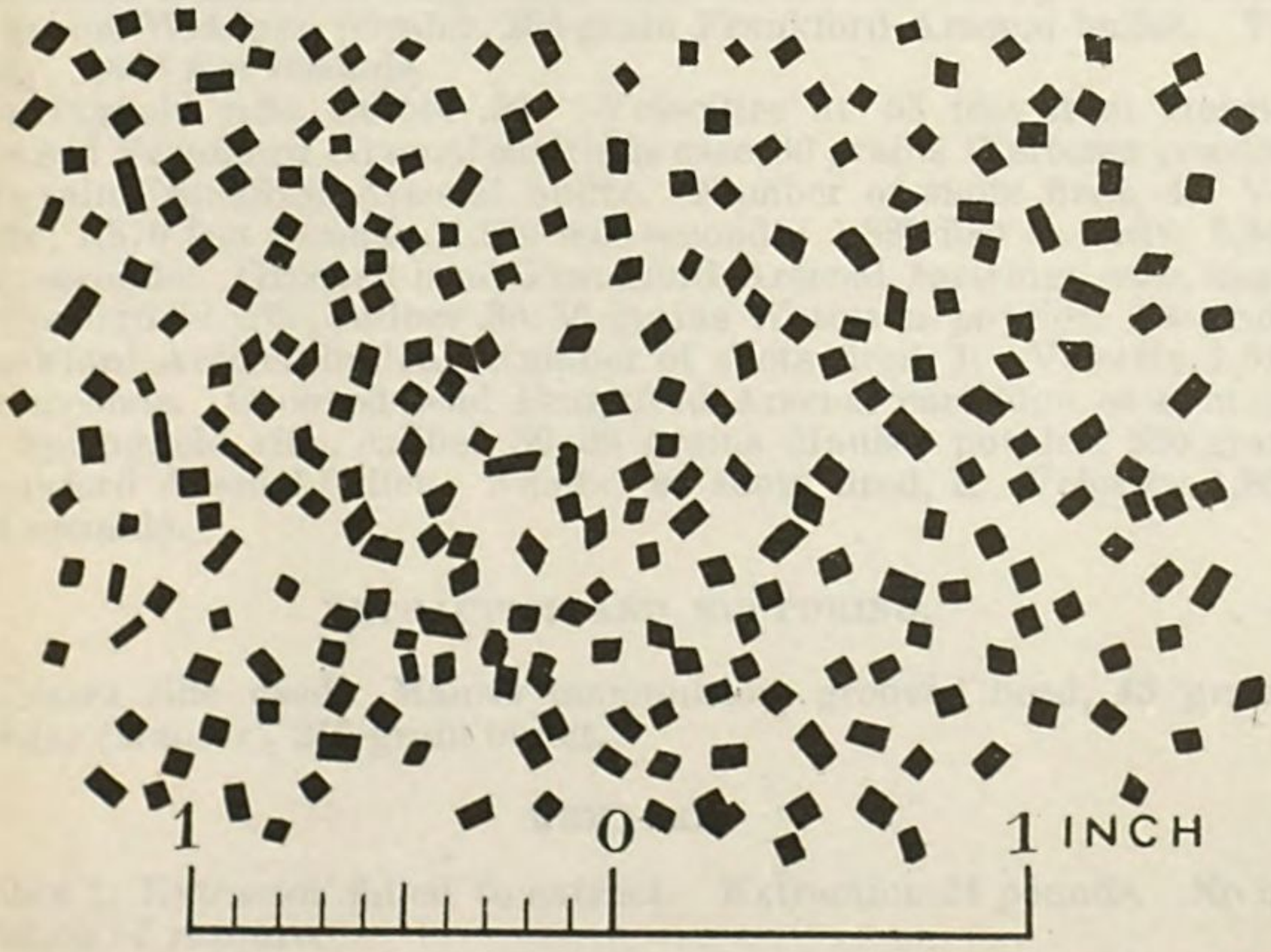
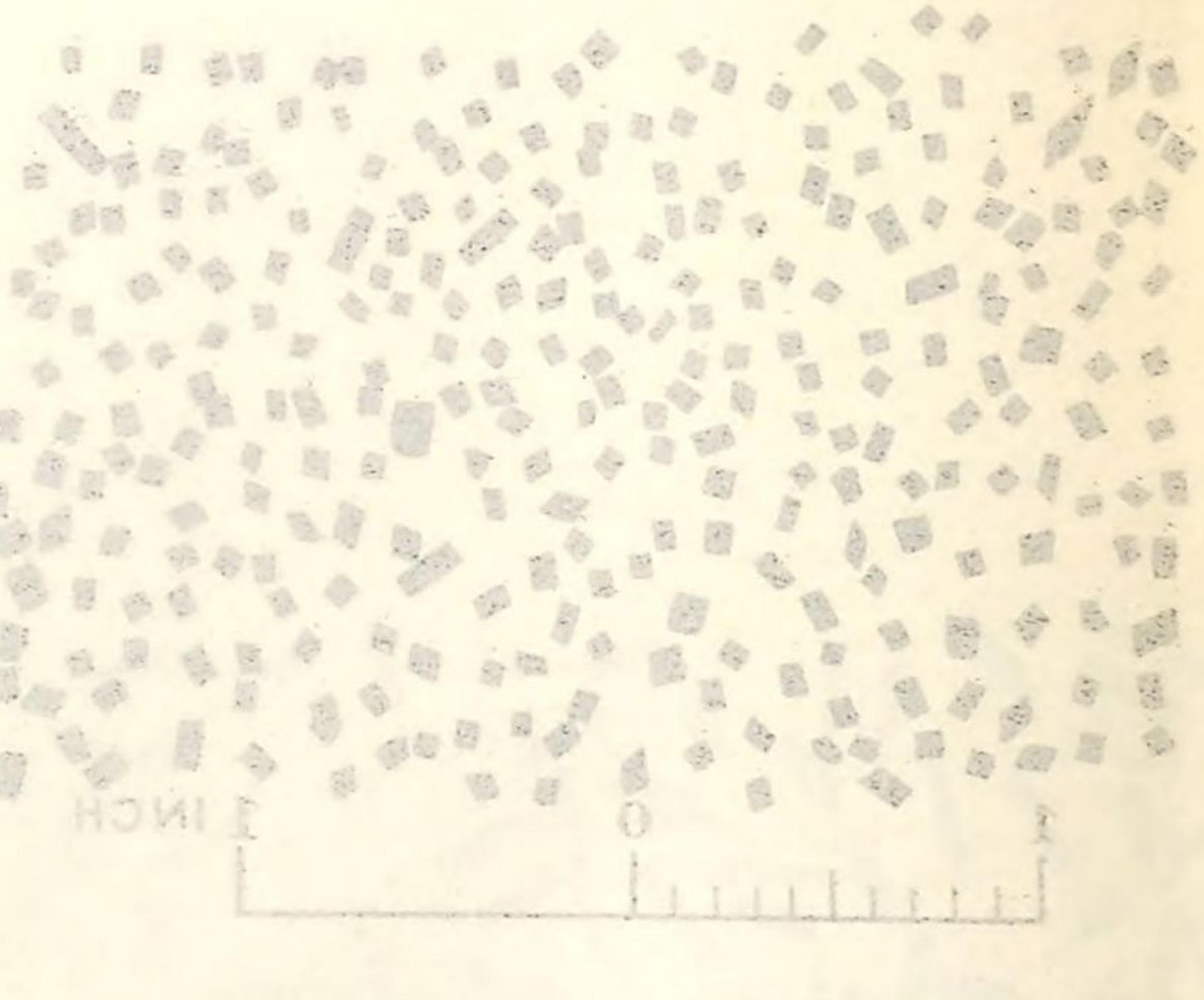


Appendix 16, 1892.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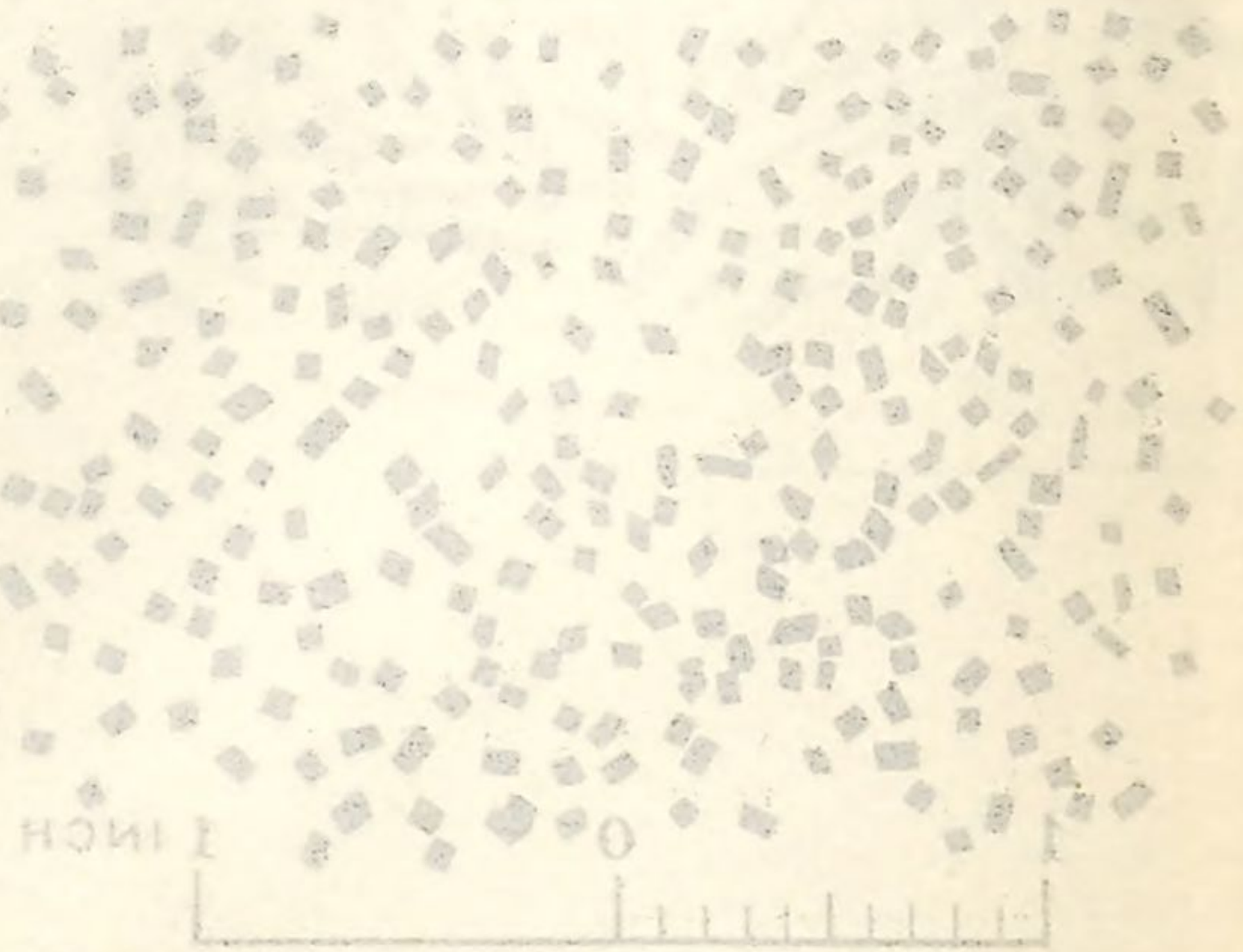
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APPENDIX 17.

REPORT ON TRIALS OF CALIBER .30, AMMUNITION WITH GROOVED HEAD, CARTRIDGE CASE.

FRANKFORD ARSENAL,
Philadelphia, Pa., June 24, 1892.

SIR: I have the honor to submit the following report on tests of Frankford Arsenal grooved-head cartridges. Two varieties were tried—one made for the Mauser rifle sent here from Springfield Armory and one made for the caliber .30 Springfield rifle. The Mauser ammunition sent here with that gun, and the flanged cartridges, caliber .30, manufactured here for the use of the Magazine Gun Board, were also tested for the purpose of affording comparisons. The Mauser cartridges contain a charge of 43 grains of a powder resembling Wetteren in color and general appearance. The bullet weighs 215 grains. Velocities were obtained as follows:

Mauser rifle. Velocities at 53 feet from muzzle. Mauser cartridge, grooved head, 43 grains powder, 215-grain bullet. Number of shots fired, 2. Velocities, 2,167 feet seconds; 2,153 feet seconds. Mauser cartridge case, grooved head, 36 grains Wetteren powder, 230-grain Frankford Arsenal bullet. Number of shots fired, 1. Velocity, 1,831 feet seconds. Frankford Arsenal cartridge case made for Mauser rifle, grooved head, 36 grains Wetteren powder, 230-grain Frankford Arsenal bullet. Velocity, 1,835 feet seconds.

Springfield rifle, caliber .30. Velocities at 53 feet from muzzle. Flanged Frankford Arsenal cartridge case, 36 grains Wetteren powder, 230-grain Frankford Arsenal bullet. Number of shots fired, 4. Velocity, 1,870 feet seconds; 1,900 feet seconds; 1,880 feet seconds; 1,873 feet seconds. Grooved-head Frankford Arsenal cartridge case, made for Springfield rifle, caliber .30, 36 grains Wetteren powder, 230-grain Frankford Arsenal bullet. Number of shots fired, 1. Velocity, 1,914 feet seconds. Grooved-head Frankford Arsenal cartridge case, made for Springfield rifle, caliber .30, 36 grains Mauser powder, 230-grain Frankford Arsenal bullet. Number of shots fired, 1. Velocity, 1,808 feet seconds.

EXTRACTION AND RUPTURING.

Mauser rifle used. Mauser ammunition, grooved head, 43 grains powder (Mauser), 215-grain bullet.

REMARKS.

Shot 1. Extractor failed to extract. Extraction 24 pounds. No indication of rupture.

Shot 2. Extractor failed to extract. Extraction 24 pounds. No indication of rupture.
Shot 3. Extractor failed to extract. Extraction 24 pounds. No indication of rupture.
Shot 4. Extracted. No indication of rupture.
Shot 5. Extractor failed to extract. Extraction 24 pounds. No indication of rupture.

Mauser rifle used Frankford Arsenal ammunition, grooved head, 36 grains powder (Wetteren), 230-grain bullet.

Shot 1. Extracted. No indication of rupture.
Shot 2. Extracted, but did not eject. No indication of rupture.
Shot 3. Extracted. No indication of rupture.
Shot 4. Extracted, but did not eject. No indication of rupture.
Shot 5. Extracted. No indication of rupture.

The Mauser extractor failed to extract in the cases noted. It showed marks of previous rough handling. The extraction was measured in these cases by a spring balance attached to the ramrod by which the cartridges were forced out. The limit of reading of this balance was 24 pounds. In the succeeding experiments a balance with a greater reading was used.

The extractor was then removed from the Mauser rifle and the ramrod was used to extract the cartridge shells both with this arm and with the Springfield rifle, caliber .30, the force required to extract being measured by the spring balance as above.

Springfield rifle, caliber .30.

[Flanged Frankford Arsenal cartridge case, made for Magazine Gun Board, 36 grains Wetteren powder, 230-grain Frankford Arsenal bullet.]

No. of shots.	Extraction.	Remarks.
	Pounds.	
1	10	No indication of rupture.
2	14	Do.
3	3	Do.
4	13	Do.
5	9½	Do.

[Grooved head Frankford Arsenal cartridge case, made for Springfield rifle, caliber .30, 36 grains Wetteren powder, 230-grain Frankford Arsenal bullet.]

1	0	No indication of rupture.
2	14	Do.
3	3	Do.
4	13	Do.
5	9½	Do.

[Grooved head Frankford Arsenal cartridge case, made for Springfield rifle, caliber .30, 36 grains Wetteren powder, 230-grain Frankford Arsenal bullet.]

1	18	Indication of rupture.
2	26	Do.
3	14	Do.
4	7	Do.
5	10	Do.

Mauser rifle.

[Mauser grooved-head cartridge, 36 grains Wetteren powder, 230-grain Frankford Arsenal bullet.]

No. of shots.	Extraction.	Remarks.
	Pounds.	
1	16	No indication of rupture.
2	18	Do.
3	24	Do.
4	0	Escape of gas. No indication of rupture.
5	24	No indication of rupture.

[Frankford Arsenal grooved-head cartridge, made for Mauser rifle, 36 grains Wetteren powder.]

1	0	No indication of rupture.
2	0	Do.
3	0	Do.
4	0	Do.
5	0	Do.

This Frankford Arsenal grooved-head cartridge case, as shown by the above record, compares favorably with the original Mauser case when fired under similar conditions, showing a decided superiority in ease of extraction. The Frankford Arsenal grooved-head cartridge case, made for the Springfield .30 caliber rifle, as in previous experiments, shows an indication of rupture whenever tested. When reloaded, these cases always rupture.

Respectfully, etc.,

J. W. BENÉT,
First Lieut., Ord. Dept., in charge Ballistic Division.

COMMANDING OFFICER FRANKFORD ARSENAL.

1217D–'92.

APPENDIX 18.

REPORT OF PRINCIPAL OPERATIONS AT WATERVLIET ARSENAL FOR THE FISCAL YEAR ENDING JUNE 30, 1892.

(7 plates.)

GUN FACTORY BUILDING.

During the year the whole building, as originally planned, has been completed. The central section and north wing were completed and reported on last year, and gun construction work has been carried on therein since November 9, 1890, gradually increasing in amount as the heavy machine tools were delivered by contractors and set up for use.

Shrinkage pit.—At the beginning of the fiscal year the equipment of the shrinkage pit in the central section had not been entirely completed and the assembling of the guns had been done at the old pit in the small gun shop, which, however, furnished inadequate facilities for the heavier calibers.

The plans of the fixtures and appliances for the shrinkage pit, and the methods of handling and shrinking together the guns, had been the subject of a good deal of study. Various arrangements by different persons were proposed. The use of gas was recommended by some as the only proper heating method and a large immersion tank by others as the only satisfactory way to cool guns, while some believed that horizontal furnaces alone would answer the purpose. Serious objections were, however, found to all these suggestions, while the locations and dimensions of the pit offered a convenient and simple arrangement of vertical coal furnaces—vertical shrinking—and water ring cooling. Such plans were, therefore, made, submitted, approved, and carried out. The first shrinking was done in this pit January 29, 1892, and 10-inch and 12-inch shrinking has been carried on there nearly continuously since that date. Very little trouble has been experienced. Minor changes had to be made in the furnaces to produce uniformity of heating, and while this has never been absolutely attained the arrangement is, upon the whole, in this respect, as well as in celerity and general convenience and good results attained, at least as satisfactory as has anywhere been produced up to this time. The old pit with its furnace and crane can be used for 10-inch guns and all smaller calibers, and the constant use of these two pits will be necessary if forgings are furnished in sufficient quantities to keep the whole completed plant of the gun factory in operation.

The 20-inch drain and tunnel for emptying the pit were completed January 30, 1892. It was intended that the whole of this work should be done by contract, and a bid was accepted for it, but the tunnel part,

extending from the east side of the pit to 12 feet outside of the east front of the building—a distance of 49 feet—was given up by the contractor when he understood that blasting would not be allowed in the tunnel. It was then undertaken by days' labor and carried through satisfactorily in less time than was expected. The excavation was through rock, and it was mainly drawn from the pit end. The dimensions were 6 by 4 feet. The material was broken out by drills, sledges, and bars, carried out to the pit and lifted up by one of the cranes. An average of 6 inches per day was taken out. The cost was about $21.83 per foot.

Plans of the pit, its furnaces, platforms, stairs and holding frames for the guns and of the tunnel and drain are sent herewith.

South wing.—My report of last year stated that the work of building this wing of the gun factory was commenced by the contractors in May, 1891, an appropriation of $248,743 having been made for the building in the preceding February. The contracts were as follows:

Troy Public Works Company (Limited), for excavations and foundation masonry	$12,950
Hilton Bridge Construction Company, for iron work, including crane runways, etc	58,800
James McFerran, for stone and brick masonry and wood work	53,945
James H. Talbott, for slate roofing, copper work, skylights, etc	9,998
Total	135,693

The plan and section of this part of the building accompanied last year's report. It was roofed in during the winter and completed in the spring. The arsenal employés have been at work since in removing the south end wall of the central section, thereby throwing the whole shop into one, in laying floors, in building the stringers, bridges and supports for shafting and the foundations for machine tools.

The contracts for the engine and boilers for this wing for the shafting and belting and heating have been let and the contractors are at work. It is expected that the machinery already set up will be running December next. The following are the contractors with the amounts:

Fitchburg Machine Works	$11,578.00
E. Gould & Eberhardt	3,180.00
Niles Tool Works	80,930.00
Niles Tool Works	73,665.00
William H. Warren Machine Tool Works	14,010.00
Pond Machine Tool Company	4,115.00
The Pratt & Whitney Company	3,250.00
Newton Machine Tool Works	2,850.00
Detrick & Harvey Machine Company	8,735.00
Philadelphia Engineering Works (Limited)	16,500.00
William Sellers & Company (Incorporated)	11,724.88
William H. Barnes	3,967.00
New York Leather Belting Company	5,607.57

This wing has over the main aisle a crane of 100 tons capacity, having a 60-foot span; it travels from end to end of the south wing and into the central section to the north side of the shrinkage pit. The power is electricity taken from a dynamo situated near the engine room, in the central section. One wire passes along each crane girder 60 feet apart; they are thus separated for safety. This is required, as the wires can not be insulated. The motions of traversing the trolley across the shop and hoisting and lowering is performed by square shafting driven by the electric motor on the crane. The travel of the crane, the movement of the trolley, and the hoists and lowerings are satisfactory. The crane has been tested with 120 tons weight, which it handles without difficulty, although the indications are that a broader belt than 12 inches,

which is now used, is needed to properly run the dynamo. Enough has been shown to establish the superiority of this great piece of mechanism. It was furnished by the Morgan Engineering Company, and was set up complete for use June 4, 1892. The shafting, belting, and pulleys for the dynamo were furnished and put in place by the arsenal.

The west aisle of this wing, which is 52 feet wide, contains the heavy jacket and hoop lathes; a traveling crane is therefore needed for the handling of these heavy pieces. The ways are erected and a 20-ton crane will in time be procured. It is also designed to have another lighter crane run on the same ways as the 100-ton crane in the middle aisle. These additions are necessary to provide facilities for the construction of 16-inch guns.

The general arrangement of machines and tools in this wing is similar to that of the north wing, *i. e.*, the long gun lathes and rifling and threading machines are in and lie across the main aisle, while the shorter and lighter machines are in the side aisles, but the arrangement of shafting and belting is simpler and more direct than that first set up. Considerable study was given to the subject, and it is thought that no plan more convenient or economical of space could be devised to transmit the power to the machinery in this wing from the engine, located as it is in the central section, or better suited, upon the whole, to the construction of the guns to be built. Drawings showing the arrangement of tools and of shafting and belting accompanies this report.

At the present time contracts have been made for the delivery of the following machine tools for the south wing, viz:

6 turning and boring lathes.
6 turning and finishing lathes.
1 rifling machine.
1 threading and slotting machine.
2 large jacket lathes.
4 36-inch lathes.
1 33-inch lathe.
4 21-inch lathes.
2 16-inch lathes.
1 72-inch lathe.
3 60-inch lathes.
3 48-inch lathes.
1 24-inch vertical drill.
1 50-inch drill.
4 cylinder boring machines.
1 72-inch vertical boring mill.
1 26-inch slotter.
1 12-inch slotter.
1 66-inch horizontal boring and drilling machine.
2 universal milling machines.
1 screw machine.
2 26-inch shapers.
2 19-inch shapers.
1 72-inch radial drill.
1 32-inch planer.
1 44-inch planer.
1 72-inch planer.
1 profiling machine.
1 vertical milling machine.
1 universal milling machine.
1 vertical spindle milling machine.
1 drill grinding machine.
1 emery wheel tool-grinder.

These tools, with the exception of the 10 large turning, boring, and finishing lathes, have mostly been delivered. Of the large machines, the rifling machine and 2 of the 10 gun lathes have been delivered and are in place.

For the final and full equipment of the gun factory the following

additional machines and tools are proposed and are to be procured from an appropriation of $346,600 made at the last session of Congress, viz:

3 turning and boring lathes for 16-inch guns, 100 inches swing, to turn and bore 50-feet lengths.
1 turning and finishing lathe for 16-inch guns, 100 inches swing, to turn 50-feet lengths.
1 turning and boring lathe to turn and bore 21-feet lengths.
1 threading and slotting machine, 22 inches diameter, 27 inches lengths.
1 rifling machine.
1 lathe, 80 inches swing.
1 lathe, 76 inches swing.
1 lathe, 60 inches swing.
2 lathes, 16 inches swing.
1 72-inch vertical turning and boring mill.
1 slotting machine, 18-inch stroke.
1 open side planer and shaper.
1 universal milling machine.
1 horizontal boring, drilling, and milling machine.
1 automatic gear-cutting machine.
Also the 60-ton and the 20-ton cranes above mentioned, differential hoists, trucks, floor scales, chucks, vises, file benches, and other shop fixtures.

These additions will fit the factory for the construction of 16-inch guns and all smaller calibers.

The north wing.—Machine tools have all been delivered and set up, and are in operation. The contractors for the gun lathes who were last year so far behind have anticipated the times of delivery and are now far in advance of the dates specified in their contracts. Thirteen gun lathes, two jacket lathes, three threading and slotting machines, and one rifling machine occupy nearly the whole of the middle aisle; while the array of vertical boring mills, horizontal and vertical drills, lathes, shapers, slotters, and planers, milling and grinding machines, in the side aisles, are conveniently arranged for work. This large shop is light and airy, comfortable in the summer and winter, and the experience so far indicates that the original plans of the Department, which have been carried out with only minor changes, will prove to have been correct and judicious.

GUN WORK.

The construction of field, siege, and seacoast guns has been prosecuted during the year both in the large and small gun shops. Twelve 8-inch guns were completed in February, 1892. Twenty-five 3.2-inch in June. Considerable work in repairs, alterations, and small fabrications has been done. Five 12-inch guns and twelve 10-inch guns are being worked on, some of them being well along toward completion, and new forgings are taken up about as fast as they arrive. The 10-inch wire-wound gun is in about the same condition that it was at the end of the last fiscal year. No jacket having been supplied, the work is necessarily suspended. Ten 7-inch siege howitzers and ten 5-inch siege guns are nearly completed; they have been longer in making than was anticipated because of changes in the rifling decided on during the progress of the construction. Twenty-four 3.6-inch field guns, sixteen 3.6-inch field mortars, and twenty-five 3.2-inch field guns (model 1890) are in process of construction.

CAST-IRON PROJECTILES

Have been fabricated during the year as heretofore. Ten thousand four hundred and fifty-nine projectiles have been made, varying in size from 3.2-inch, weighing 13½ pounds, to 12-inch gun shot and 12-inch mortar shell, weighing 1,000 pounds.

Forty-five steel forgings have been finished into 7-inch experimental shell and 50 steel castings into similar shell. Twenty-five steel shell for 12.2-inch mortar are being finished.

In the foundry 35 tons of machinery castings have been made for the various needs of the work going on in the other shops.

FIELD CAISSONS AND LIMBERS, BATTERY WAGONS AND FORGES.

The work of making these carriages for the light batteries has continued during the year; minor changes have been made to overcome slight defects developed by service. The 25 caissons, 50 limbers, and 6 combined battery wagons and forges worked on during the preceding year were completed in the autumn of 1891, and another order for 25 caissons and limbers with 6 combined battery wagons and forges are nearly finished.

Locomotive and car for transporting guns and heavy loads to and from the wharf and through the grounds were much needed. An appropriation of $9,000 was obtained in 1891. Bids were received in answer to advertisement, and contracts made with the Rogers Locomotive Works, of Paterson, N. J., for the locomotive, and with the Baldwin Locomotive Works, of Philadelphia, Pa., for the car, capable of carrying 60 tons. Both were received during the winter, have been in use, and are satisfactory.

PAVING ROADS WITH GRANITE BLOCKS.

An appropriation of $5,000 was obtained for this purpose. Ten thousand six hundred and forty-two square feet of road was paved in the most substantial manner. The foundation is of broken stone, well rolled with a heavy steam roller. The granite blocks are of good quality and uniform size. The avenue from the main gate to and past the office was paved; also the causeway from the bridge to its junction with the macadam roads laid during the previous year.

Further paving is needed and another appropriation of $5,000 has been made for the purpose.

The extensive grounds and roads have been kept in order and gradually improved. Repairs have been made to public buildings and fences. The duties of issuing and receiving stores and material and the clerical work have been faithfully and promptly performed.

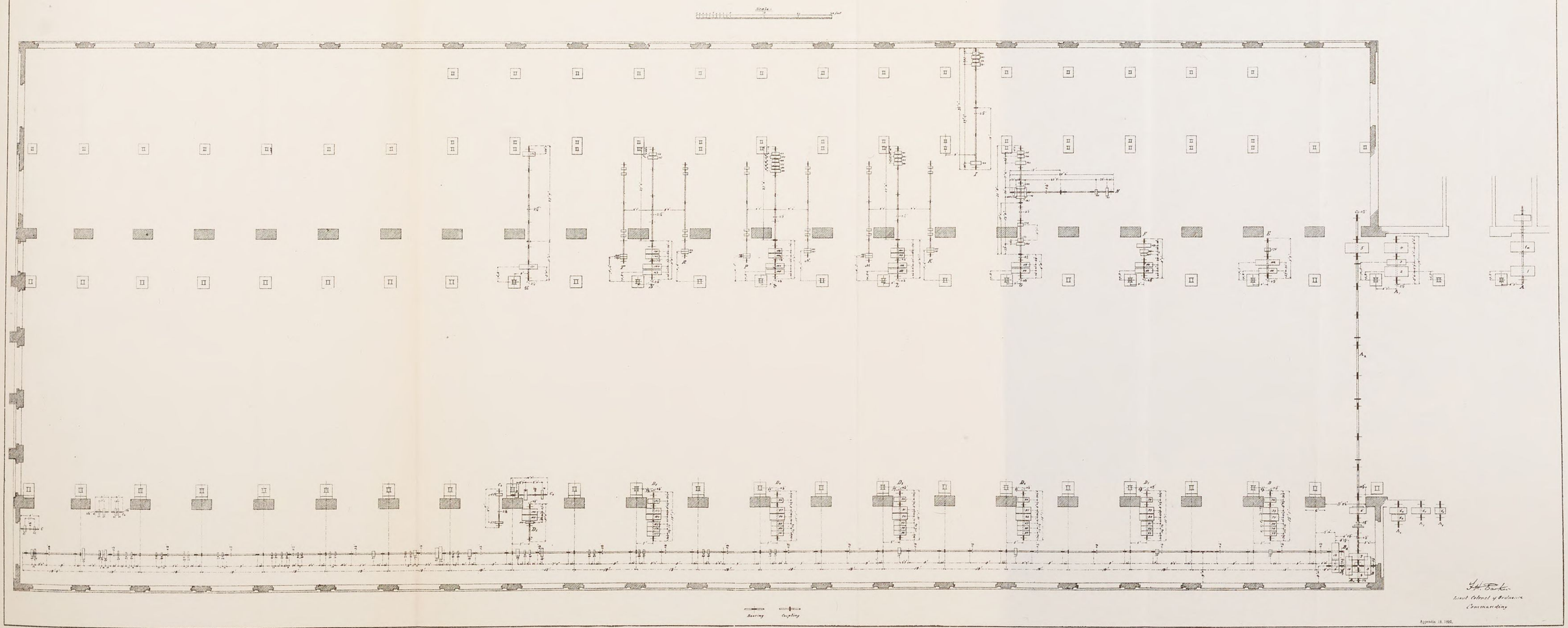
F. H. PARKER,
Lieut. Col., Ord. Dept., U. S. Army, Commanding.

(4904–'92.)

ARMY GUN FACTORY.

WATERVLIET ARSENAL, U.S.A.

Transmission of Power.



F. H. Cook
Lieut. Colonel of Ordnance
Commanding

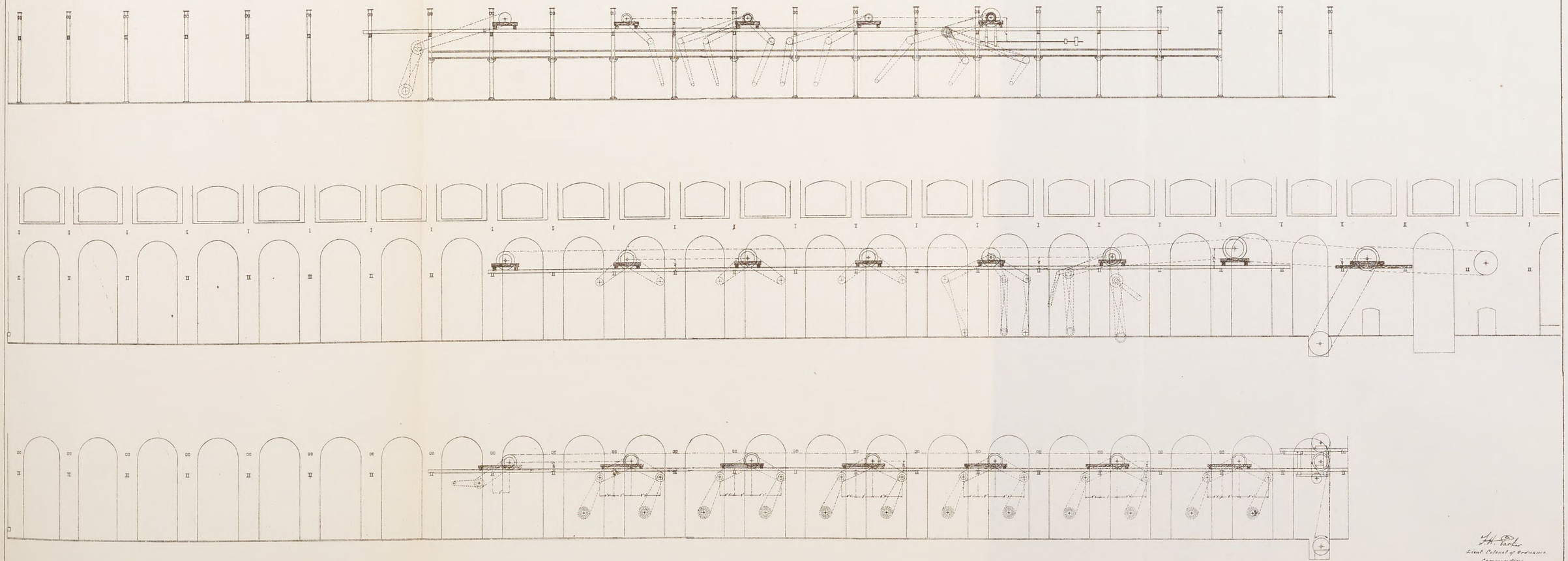
Appendix 18, 1902.

ARMY GUN FACTORY.

WATERVLIET ARSENAL U.S.A.

Transmission of Power.

Scale



F. H. Parker
Lieut. Colonel of Ordnance
Commanding

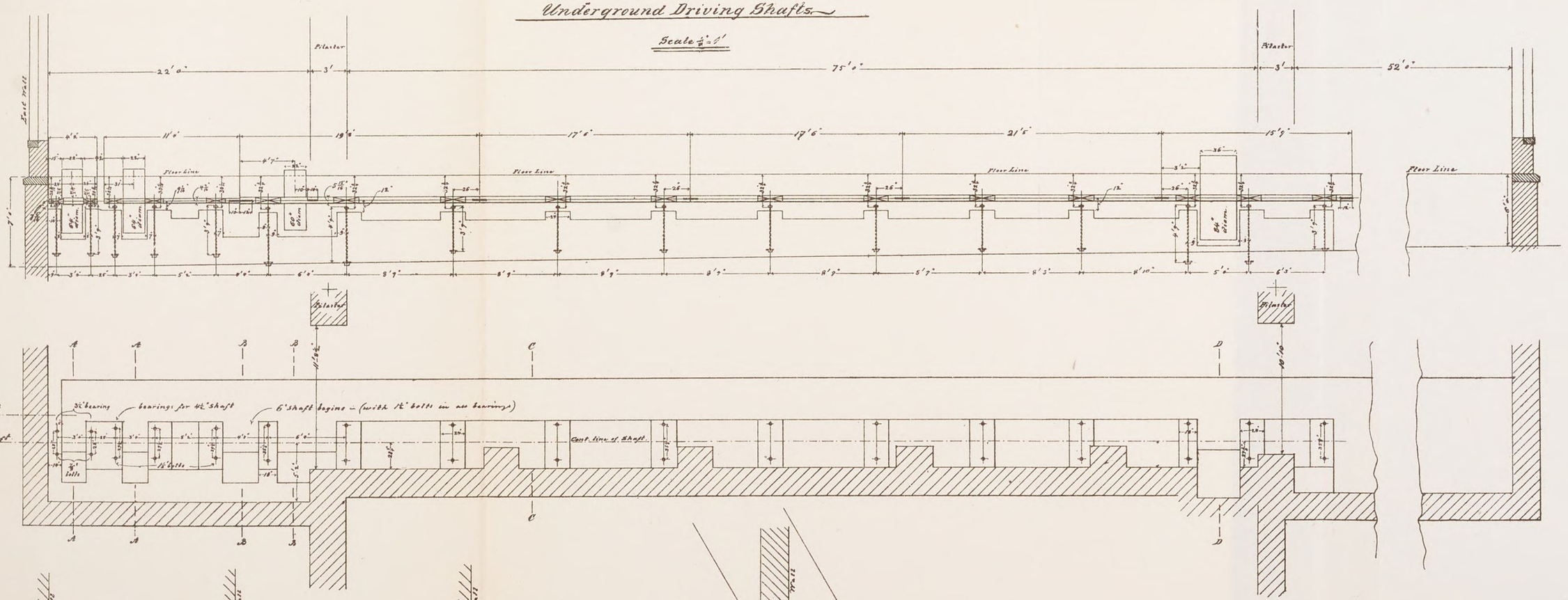
Appendix 13. 1892.

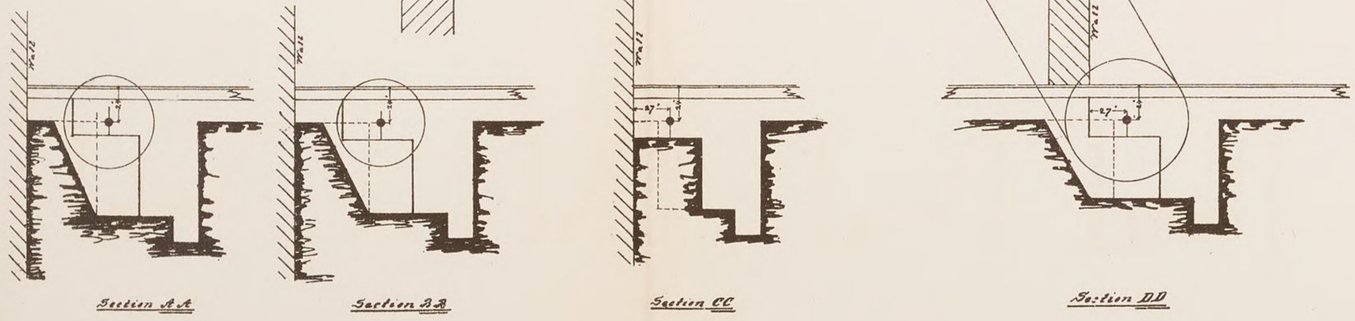
Watervliet Arsenal 23d Febr. 1892

PLATE III.

South Wing
Underground Driving Shafts.

Scale $\frac{1}{8}$" = 1'

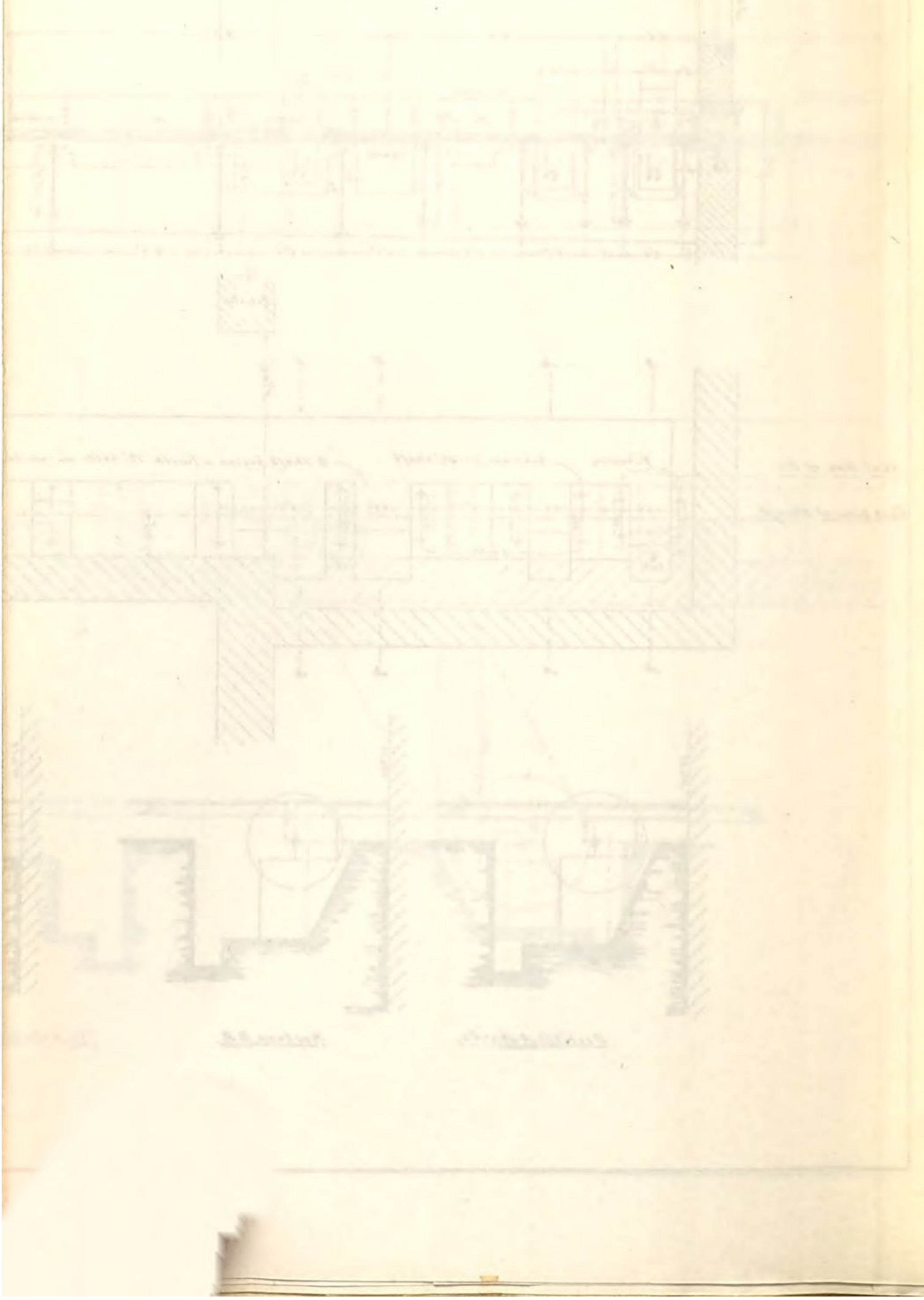




F. H. Parker
Lieut. Colonel of Ordnance
Commanding

Appendix 18. 1892.

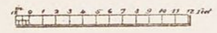
Ord 52 2

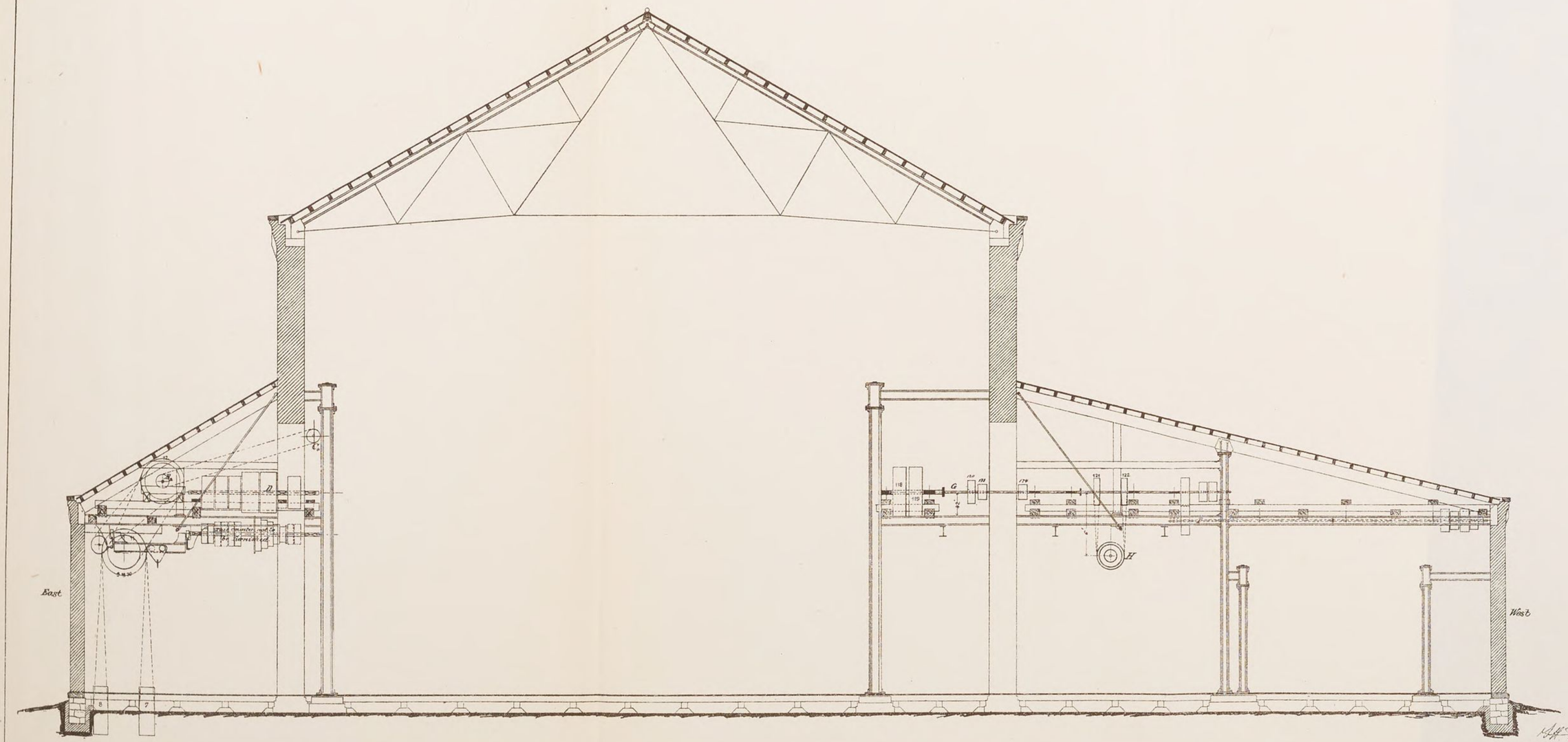


ARMY GUN FACTORY.

WATERVLIET ARSENAL U.S.A.

Transmission of Power.





Lieut. Colonel of Ordnance
Commanding.

Appendix 19, 1892.

Ord 52 2

PLATE V.

Army Gunfactory

Watervliet Arsenal U. S. A. Location of Machinery

Scale 1/8" = 1 foot

Appendix 18, 1892.

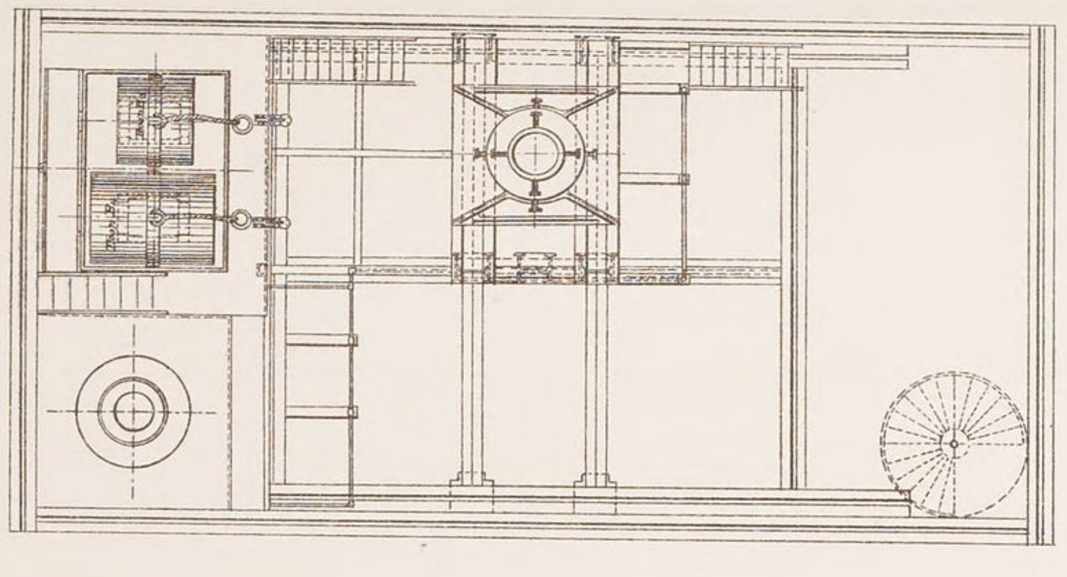
Lt Colonel Ord. Dept.

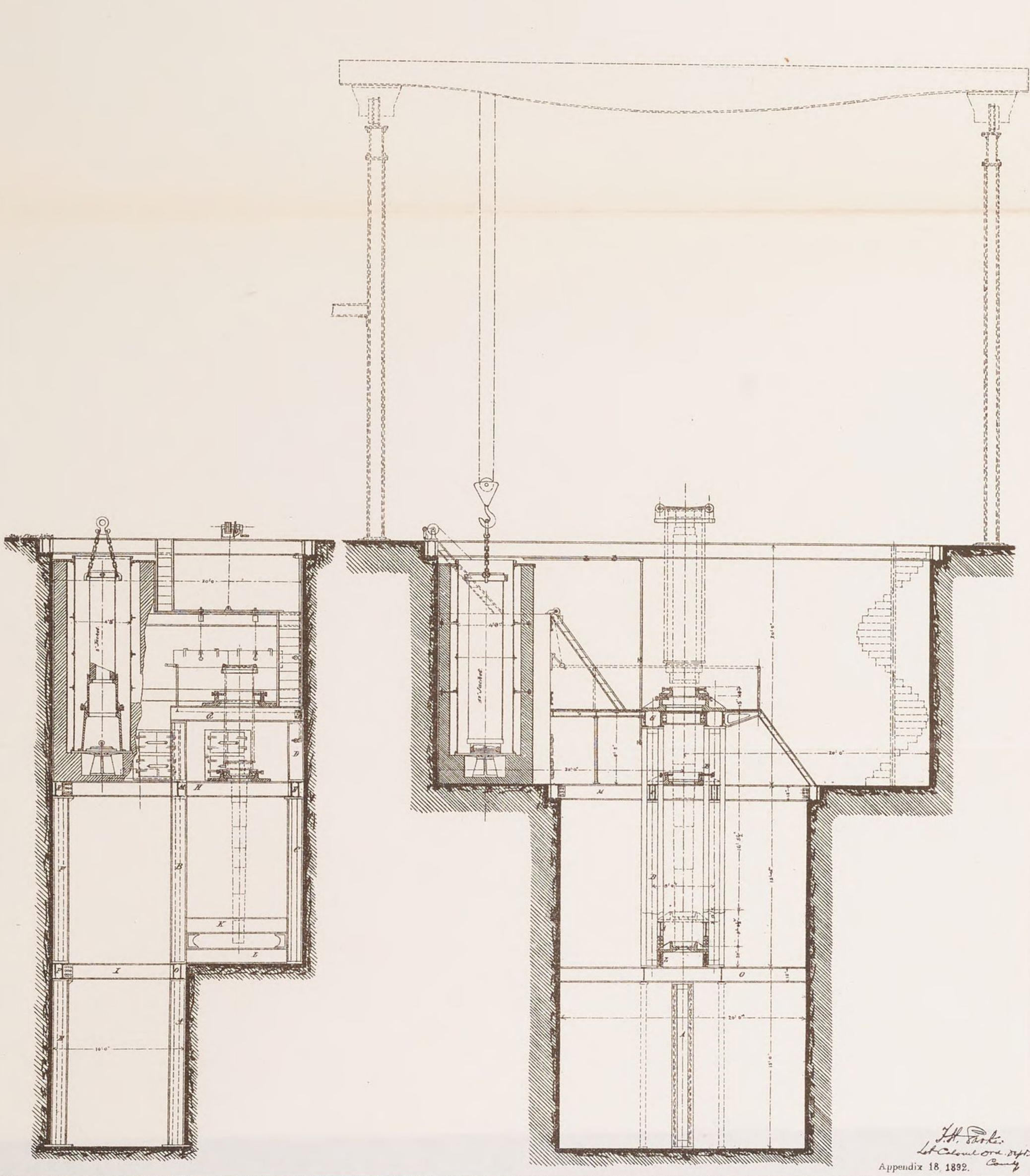
Watervliet Arsenal Feb. 13th 1891

PLATE VI.

HEATING FURNACES.

Scale 1 inch = 1 foot

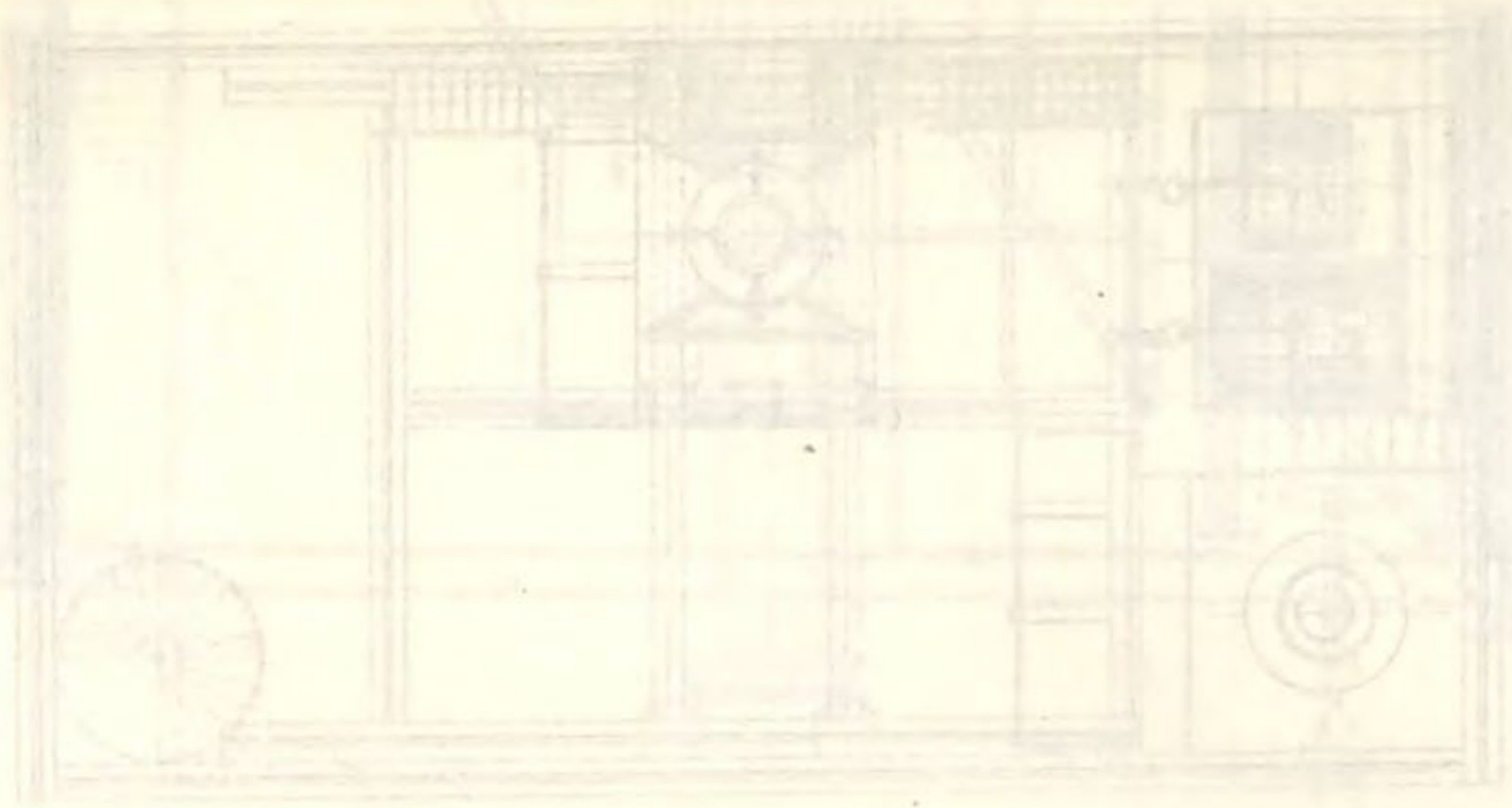




F. H. Brooke
Lt Colonel Ord. Dept. U.S.A.
Comdg

Appendix 18, 1892.

Ord 52 2

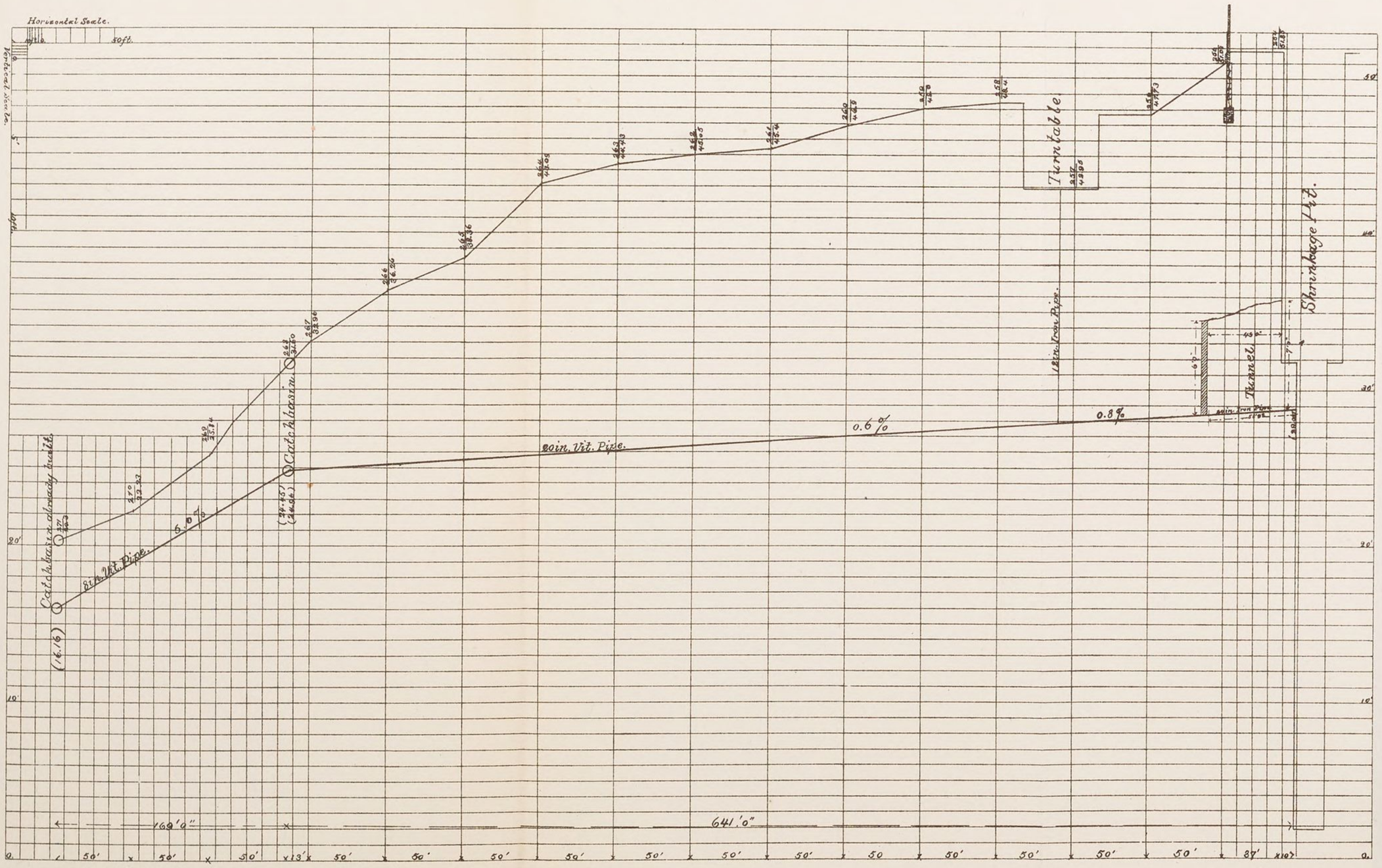


Watervliet Arsenal, July 30th 1891.

PLATE VII.

Profile of 20in. Drain from Shrinkage Pit.

Scale. 10ft. Hor. 1ft. Vert.



Appendix 18, 1892.

S H Parker
Lt Colonel Ord Dept. U.S.A.
Comdg.

Ord 52 2

APPENDIX 19.

SPECIFICATIONS FOR A STEAM-POWER PLANT FOR THE ARMY GUN FACTORY AT THE WATERVLIET ARSENAL, WEST TROY, N. Y.

This steam-power plant consists of a complete engine and boiler plant, and comprises, mainly, one 250-horse-power duplex steam engine, three horizontal tubular steam boilers, one feed-water heater, one steam pump, and one injector; all complete, with all accessories, as specified.

The accompanying blue print of boiler and engine rooms gives all dimensions required for making an intelligent and correct bid, and shows location of engines and boilers as desired. These localities are now in readiness for the reception of the steam-power plant. The plant must be erected and put in successful operation by the contractor, and bidders will state the price for the installation of the plant, ready for belting, with steam on.

Anything required toward the erection and completion of the plant; all skill and unskilled labor; all materials and tools, including excavations, foundations, and other masonry; base stones for engine; all necessary cutting and building up in wall and roofs, etc., also all necessary drawings, must be furnished by the contractor. He is to comply with the State and other laws during the execution of his contract, and is responsible for all injury and loss of life and limb to his employés.

The United States will perform all necessary work pertaining to the wooden floor of engine room and prepare the concrete floor in boiler house, but nothing else.

The engine-floor level is 4 feet 9 inches above ground line, and the boiler-house-floor level will be 2 feet above ground line. The ground is solid shale rock and is nearly level.

Further excavations for the foundations of engine and boilers should be dispensed with as much as possible, if not entirely.

Bidders will furnish a general installation plan, in harmony with the accompanying blue prints, showing also all pipe-lines, also such designs of engines, boilers, and boiler-setting, etc., as will enable the Department to attain satisfactory knowledge of the merits of all principal parts. An exhaustive description of all parts of the plant must also accompany the bids.

Photographs are desirable, but not absolutely necessary; cuts alone accompanying bids can not be considered.

A railroad track connecting with the tracks of the Delaware and Hudson Railroad runs into the gun factory building very close up to engine room, while another track passes within 50 feet of the main entrance of the boiler-house.

Bidders will state the time within which they will erect and put in successful operation the entire plant. If any delay occurs in the completion of the plant, in perfect running order, beyond the date specified,

a reduction shall be made in the price of said plant of $20 per day for each and every day (excepting Sundays) after said date until the completion of the plant.

Payments will be made in two installments of 50 per cent each. The first payment to be made on delivery of engine, boilers, etc., at the gun factory building, and the second upon final acceptance of the whole work by the United States, after a continuous successful operation of the plant of 20 working days, but in no case later than 60 days after the complete erection of the same.

ENGINE PLANT, ETC.

The engine will be a 250-horse-power horizontal duplex steam engine; the available floor space for same is 25 feet long and 14 feet wide; the height of roof trusses above floor line and the position of drive pulley and its supporting girder are shown in blue print.

The foundations for the engines must be prepared at an early date in order to allow the masonry to set properly before the engines are erected on same.

This engine must develop at its medium economical point of cut-off, under 80 pounds of steam, not less than 250 indicated horse power. Bidder must state in bid at which point of cut-off the 250 horse power will be developed.

Each engine of the pair must be capable of developing, in case of need, 200 horse power readily and continuously without injury, though best economy in use of steam is not called for at this load.

The engines must be guaranteed not to vary their number of revolutions per minute more than 1½ per centum, plus or minus, if such whole load is not beyond the rated power of the engine.

The engines are to drive a pulley of 7 feet diameter by 36 inches face on the main-line shaft, at the rate of 150 revolutions per minute, in the direction indicated in blue print.

The closest economy of steam obtainable from duplex engines of this rated horse power shall be guaranteed.

Net weight of finished wheel to be stated by bidder.

The shaft to be of forged mild steel.

Cylinders to be of first-class charcoal iron, as hard as can be worked with the usual tools for this purpose, free from all defects. The bore to be round and parallel, and properly recessed at each end.

Steam and exhaust passages to be ample for speed engine is to run. The steam admission must be such as to deliver steam into the cylinders with a loss of not to exceed 1½ pounds from that carried to the steam stop valves of engines, and the exhaust valves must permit the escape of the waste steam at not to exceed ½ pound above the atmospheric pressure.

Valves and seats to have a perfect (scraped) fit, and the construction should admit that they be readily accessible and retained perfectly tight. Special consideration will be given to this as well as to a small clearance, large port areas, a perfect piston packing and simplicity of the valve gear.

Cylinders to be drilled, tapped, and piped for indicator with three way cocks in middle. All indicator pipes and fittings to be nickel plated.

Cylinders to be nicely cased with cast-iron paneled lagging in as few pieces as practicable, or with hard wood with plated bands.

Girder frame to be of ample strength and symmetrical proportion.

Bearings to be provided with quarter boxes and set screws for taking up wear in the usual manner, or other suitable means for this purpose. They must be provided with neat and substantial means for collecting the surplus oil from main bearings. Piston rods, cranks, cross heads, and all other pins to be of forged steel, round and parallel; oil channels in all boxes; all bearing surfaces to be scraped to a fit. All parts not easily handled otherwise to be drilled and tapped in two places with holes for the insertion of lifting handles, which must be furnished.

Governor to be connected with cut-off mechanism in such a manner that it will automatically keep the speed of engine as desired with wide-open throttle under any reasonable variation of load. The engines must be properly connected with the main steam pipe above boilers, and a suitable stop valve is to be interposed at the point of junction to shut off steam to engine room entirely, but each cylinder, of course, will have its individual stop valve. All pipes must be properly hung to roof construction or otherwise well secured to the building. Proper provision must be made to compensate for expansion in the pipe lines. All valves, fittings, etc., required in connections between steam pipes and cylinders must be furnished. The exhaust pipe must be located underneath the engine-room floor, and must be provided with a full-size nozzle with blank flange, facing toward the main part of the building, while its direction must be in a straight line toward the partition wall between boiler and engine rooms. There it will be connected to a feed-water heater. This part of the exhaust pipe (between cylinders and feed-water heater) is to be provided with an 8-inch nozzle—standing upward and provided with a blank flange—close to the east face of the partition wall between engine and boiler rooms, while a back-pressure valve of proper construction and size is to be interposed between this partition wall and the feed-water heater. Upon leaving this heater it must be carried up to and through the roof of the engine room to a height of not less than 3 feet above the roof surface. An exhaust head of same type as the one in use now is to be placed at this end of exhaust pipe, the condensed water to be carried off as will be directed hereafter. The roof must be made tight where pipe passes through. The feed-water heater will be placed on the boiler house side of wall.

A first-class tubed feed-water heater (Wainright or equal) of proper capacity for 500 horse power of boilers must be furnished and erected on floor of boiler room, and properly connected with exhaust pipe, as stated. All water connections from pump to heater and from the latter to the boilers must be properly made. A relief valve of proper construction must be suitably interposed and properly connected between feed-water discharge of heater and main water pipe.

All pipes, cylinders, pump, heater, etc., to be properly dripped. The drips from engine cylinders to lead into exhaust pipe behind the relief valve. The drips from bottom of feed-water heater and from steam pump, also waste pipe from injector, to lead into a 2-inch waste pipe, which is to be placed into the same trough as the blow-off pipe (in rear of boiler). This pipe must be carried north along the rear of the present boilers, and the drip from cylinders, pump, injector, heater, etc., of the present power plant must be suitably connected with it before it leaves the north wall, after which it leads into a pot outside of building. No connection is allowed between this pipe and the blow-off pipe from boilers, inside the boiler house. The blow-out pipe from heater must be connected with the blow-off pipe of boilers. All steam and

exhaust pipes to be of heavy cast iron, flanged. Thickness of metal to be ample, and to be stated in bid. All steam pipes must be tested by the contractor with a warm-water pressure of not less than 200 pounds per square inch before making connections. All connections in steam and exhaust pipes to be flange connections. All flanges to be faced, bolt holes to be drilled. Connections must be made perfectly steam-tight. Fittings to be of cast iron, heavy, except where brass piping is used, when they must be of brass of approved quality. All steam and exhaust pipes to be covered with sectional covering, either magnesia covering or equal. Each engine to have a steam stop valve of first-class construction, an automatic sight-feed lubricator of approved pattern, and a complete set of automatic oil cups, wrenches, etc. Automatic oil cups to be of the open drop-feed type of approved make.

Besides all parts, fittings and fixtures required for engine, feed-water heater, and pipe connections, the following articles must be furnished:

A heavy brass-pipe railing of same size and description as that around present engine, surrounding fly wheel and all moving parts of engine completely. Said railing to be fastened to floor by brass sockets.

One black walnut gauge frame to hold clock, steam and back pressure gauges and engine register; dials to be 8½ inches diameter. Gauges to be of Ashcroft manufacture. All instruments must be properly connected to engine and must be located at a place to be designated.

A 3-inch connection must be made, with interposed valve, between main steam pipe over boilers and steam-whistle pipe.

Material, workmanship, and finish in general.—All iron castings to be made of best quality pig iron; no miscellaneous scrap to be used. All steel and iron forgings to be of the best quality.

All bronze castings to be made from Lake Superior copper and tin; no old metal to be used. Workmanship and finish to be first class, and to be open to inspection at all stages of the work.

All parts of engine not having bright finish will be thoroughly filled and rubbed down with filling and prepared for painting. The last coat of paint to be applied after engine has been completely erected. Color the same as that of present engine.

The engine will be located as shown on blue print; the position of pulley on line shaft, as figured, is fixed.

BOILER PLANT, ETC.

Number and arrangement of boilers.—Plant to consist of three boilers arranged in a row, and located as shown on blue print.

Type and dimensions.—Boilers to be of the horizontal tubular type, to be 72 inches in diameter by 16 feet long; steam dome 36 by 36 inches, to be placed in center of middle course.

Tubes.—Boilers to contain one hundred and four 3½-inch best lap-welded tubes, each 16 feet long, set in vertical and horizontal rows, with a clear space between them of 1 inch, vertically and horizontally, except the central vertical space, which is to be 2½ inches wide, all as shown on accompanying diagram of tube sheet. Center of top row of tubes to be 10 inches above center line of boiler.

Tube holes through heads to be neatly chamfered, and to be set with a "Dudgeon expander." Ends of tubes to project beyond heads ⅜ inch, and ends to be flared, but not beaded over. Space between tubes and shell must not be less than 2 inches.

Material.—The shell of boilers and domes, also main heads and head of domes, to be of first-class open-hearth fire-box steel of domestic man-

ufacture. Shell of boilers to be in three courses, each course one sheet, seam of first course lapping away from fire. Lower half of first course to project 16 inches from tube sheet. This projection to be dripped.

Front and back heads same diameter.

All extra laps to be trimmed off.

Shell of boilers to be $\frac{7}{16}$ inch thick.

Shell of dome to be $\frac{3}{8}$ inch thick. Head of boilers and dome to be $\frac{1}{2}$ inch thick. All this material to have a tensile strength of not less than 55,000 pounds nor more than 60,000 pounds per square inch of section, with not less than 55 per cent of contraction of area at point of fracture and an elongation of not less than 25 per cent in a length of 8 inches.

All plates must be plainly stamped with name of maker, brand, and tensile strength brands so located that they may be seen on each plate after the boiler is finished. Each shell plate must bear a coupon, which shall be sheared off, finished up, and tested in the Government testing machine at Watertown Arsenal, Massachusetts.

The coupons must be stamped with numbers corresponding to numbers of sheets from which they are taken.

Tests will be made at Government expense, and contractor will forward coupons for this purpose to the commanding officer of the Watervliet Arsenal.

Each coupon must fulfill the above requirements as to strength and ductility, and must also stand bending down double when cold, when red hot, and after being heated red hot and quenched in cold water, without signs of fracture. Any and all plates failing to pass these tests will be rejected.

Riveting.—The longitudinal seams of these boilers must be of the triple-riveted butt-joint type with double-covering strips. They must be arranged to come as near as possible above the horizontal plane through the center of boilers, and must break joints in the different courses in the usual manner. Flange seams of domes (at junction with shell of boiler), also vertical seams of domes, to be staggered riveted. All girth seams to be lapped and single riveted. The boilers to be riveted with $\frac{7}{8}$-inch rivets throughout, which must be of ample length to form up heads equal in strength to the pressed head of same. All rivets to be spaced $2\frac{3}{16}$ inches between centers. The preference is for drilled holes; if drilled they must be neatly chamfered $\frac{1}{32}$ of an inch on the faying sides of plates and covering strips.

If the holes are punched, each shell plate and head must be thoroughly annealed after punching, and the rivet holes must be chamfered sufficiently to remove any burr that may be formed in punching. No rivets shall be driven in unfair holes; such holes must be brought in line with a reamer. No drift pins must be used in the construction of the boilers.

Flanging.—All flanges to be turned in a neat manner to a radius of 2 inches, and to be clear of flaws, checks, and hammer marks.

Bracing.—There must be at least thirty-six braces of 1 inch diameter in each boiler above the tubes, eighteen on front head and eighteen on back head, of solid crow-foot forms. Braces to be equally distributed on heads as shown on the tube sheet. None of them shall be less than $3\frac{1}{2}$ feet long and those of the lower row to reach to second course of shell, care to be taken to leave space for access to boiler between braces beneath manhole. Each brace must be fastened to shell and heads by two $\frac{3}{4}$-inch rivets at each end. Care must be taken in setting them that they may have uniform tension.

Bracing of domes.—Domes to have four $2\frac{1}{2}$ by $\frac{1}{2}$ inch flat iron crow-foot braces about 12 inches long, reaching from shell of boiler to shell

of dome, to reënforce the flange seam, riveted with two $\frac{3}{4}$-inch rivets at each end. Head of domes to be braced to shell by six 1-inch crow-foot braces.

Manholes.—The boilers to have a cast-iron manhole mouth piece 11 by 16 inches (extra heavy), securely riveted to shell of boilers on top of rear course (back of dome), and to be furnished with cover and fastenings. Another manhole, 11 by 15 inches, is to be cut into front head of boilers below tubes, and is to have a stiffening ring of 2 inches by $\frac{5}{8}$ inch flat iron riveted around the same.

A manhole cover of cast iron and proper fastenings to be furnished to this manhole. A cast-iron frame to be set over top of manhole of 24 inches interior diameter, with its lower extremity fitting on shell of boiler, while its upper end is to project above top of arch, is to be provided for each boiler, and is to have a cast-iron slip cover on top. This cover to have suitable handles for its removal for access into boiler.

Openings in domes.—Two openings, 10 inches diameter each, 16 inches centers, to be cut girthwise into shell of boiler beneath dome.

Drip holes.—Drip holes must be provided at or near junction of shell and dome.

Brackets, etc.—Each boiler to have six cast-iron brackets, three on each side, securely riveted with six 1-inch rivets each to shell; brackets to be 12 inches long, with a projection of 12 inches from boiler, and to be in level with center line of top row of tubes.

Cast-iron wall plates, 24 inches long, 12 inches wide, and $1\frac{1}{2}$ inches thick, must be furnished for each bracket to rest upon, and three rollers 1 inch in diameter and 10 inches long must be furnished for rear and center brackets to rest upon, to allow free expansion of boiler.

Nozzles.—Each dome head to be provided with two cast-iron flanged nozzles, one 6 inches internal diameter for steam-pipe connection, and one 6 inches internal diameter for safety-valve connection, both to be faced and drilled on top flange, and securely riveted to dome head behind each other, the safety valve to be in front.

Feed pipe.—Each boiler must have a hole tapped for $1\frac{1}{2}$-inch pipe in center of front head, 3 inches above the top of upper row of tubes, for feed-pipe connections.

The feed pipe must be of seamless drawn brass pipe, $1\frac{1}{2}$ inches diameter.

It must be securely screwed into the head and run back front to rear to within 2 feet of the back head, the end to be provided with a cap.

The feed pipe as far as within the boiler to be provided with three rows of $\frac{3}{8}$-inch holes, 2 inches centers, drilled staggered, one row at bottom of pipe and one on each side at angles of 30°. Feed pipe to be properly hung from the braces. All parts of pipes located in furnaces or flues to be extra heavy and to be heavily covered with asbestos cloth.

Blow-off pipe.—Each boiler to have a circular plate of shell steel 7 inches in diameter and $\frac{1}{2}$ inch thick, riveted to bottom of shell 8 inches from back end, and tapped to receive a 2-inch blow-off pipe, which must be extra heavy and wrapped with asbestos cloth as far as located in furnace.

Fusible plug.—Each boiler to be provided with a fusible plug in back head, 2 inches above top of upper row of tubes.

Safety valve, steam gauge, gauge cocks, and gauge glass.—Each boiler must be provided with one nickel-seated Ashcroft pop safety valve 5 inches in diameter, securely bolted to nozzle on top of dome; one nickel-plated 8-inch Ashcroft steam gauge, with siphon and stopcock; one

combination water column with ¾-inch gauge glass and three ¾-inch gauge cocks; the steam and water connections between it and boiler must be made by pipes not less than 1¼ inches diameter, and valves must be interposed between water columns and boiler in steam and water connections; one 2-inch brass asbestos blow-off cock; one 6-inch brass stop valve of approved pattern, securely bolted to nozzle on top of boiler; one 2-inch brass valve to be connected with blow-off pipe above blow-off cock. All valves of 2 inches and less in diameter to be Fairbanks asbestos disk valves.

Castings for setting.—The boilers must be provided with a full cast-iron front of like design as the present one for all three boilers, with (double) flue, furnace, and ash-pit doors with all necessary fastenings.

The flue doors to project from main face of front (dished), and corners to be well and nicely rounded. They must have a perforated cast-iron lining plate fastened to each wing in such a manner that face of lining plates may be about in same plane with face of front. Doors to be properly fitted, and chipped to have a uniform bearing against their faces.

Furnace doors (36 inch) and frames must be of Ashcroft-Martin's balanced furnace-door pattern, as manufactured by the Ashcroft Manufacturing Company, Bridgeport, Conn.

The front must have a suitable cornice on top and brackets for the reception of steam gauges and feed pipes.

The end column of front to be separate pieces, ⊥-shaped. Through these pieces go the necessary tie rods to tie the brick work transversely and longitudinally together and to hold the front. Tie rods to pass front to rear must be also between each two boilers, located in interspace of masonry. No tie rods must be built into the brick work; they must be located on the outside in recesses left for that purpose in the brick work.

The cross tie rods in front to be on the inside of the cast-iron fronts.

The whole front to be made in suitable sections, bolted together on the inside and well ribbed on back to prevent warping and cracks. Joints to be covered. Fronts must be arranged so as to be able to remove any one of the boilers for repairs, or otherwise, without disturbing the others.

For each boiler must be furnished a back-flue door and frame, about 16 by 24 inches.

Dead plate to have a socket on each side for the reception of the special pillar tiles supporting the arch tile over furnace mouth.

Two heavy cast-iron return-flue lintels, 7 feet long by 18 inches wide and 1½ inches thick, with a central rib 8 inches high, lengthwise, to cover return flue in rear of each boiler. A damper frame with cast-iron damper, about 22 by 32 inches, with chain, pulleys, and counterweight complete, is required for each boiler.

Ten heavy backstays are shown in blue print with the necessary 1-inch brace rods, to be furnished to bind brick work cross-wise, top and bottom; also, all other tie rods, washers, etc., and a strap of 6 inches by 1 inch flat iron across rear wall of boilers.

Grates to be of proper size for anthracite furnace coal and to be of the Ashcroft-Martin type, as manufactured by the Ashcroft Manufacturing Company, Bridgeport, Conn., with square wrought-iron grate bars, wrenches, and all appurtenances required for operating grate. Grate bars to be of dimensions given in blue print.

Flues.—The gases of combustion are carried over top of boilers to the back end, passing through dampers into flues of proper area and of form as shown in blue print, and thence into the chimney. These masonry

flues must be properly supported on heavily ribbed cast-iron lintels or plates of ample strength, resting on rail bars and on a girder of ample strength, supported on two heavy cast-iron columns and on a channel built into back wall of boilers, all as shown in blue print.

All must be properly anchored and secured. These plates must be covered with two courses of brick, laid flat, the upper course to be of fire-brick.

The flues to be covered on top with ribbed plates of cast iron, resting on masonry, and of suitable form and size to cover flues up to chimney. These plates to be covered with two courses of brick laid flat.

The space underneath flues and between back wall of boilers and partition wall and chimney forms a passage for access to rear of boilers for cleaning, etc.

Blow-off connections.—The 2-inch blow-off pipe of each boiler must be of brass from boiler to blow-off cock on rear end of back wall, thence of 2-inch wrought-iron lap-welded pipe leading to trough in floor, where all blow-offs are connected with a 3-inch pipe leading north to the rear of present boiler plant. There it must be increased to 4 inches in diameter and leave the boiler-house through existing opening in north wall. Outside this wall a heavy cast-iron pot, of about 2 feet diameter and suitable depth, with steam-tight cover, must be provided. With this pot must be steam-tight connected the 2-inch drip pipe from engine cylinders, etc., and the 4-inch blow-off pipe from boilers. The existing 4-inch drain pipe to manhole must be also steam-tight connected to the pot. All pipe connections to be as high as possible above bottom of pot, but the two inlet pipes must be heated higher than the outlet pipe.

The drip pipe from engines, pumps, etc., and also the main blow-off pipe from boilers must be laid into a heavy cast-iron trough, with cover, of suitable dimensions to allow access to pipes for repair. This trough must begin at blow-off of first boiler on south end of plant and terminate at north wall of boiler house.

The contractor has to break pipe connections and make new connections with the present steam and power plant in accordance with the above without extra compensation. He will also interpose a 2-inch brass stop valve in blow-off pipes, above blow-off cocks of the three existing boilers, to correspond with the similar arrangement on new boilers.

Feed-water connections.—All necessary feed-water connections must be made from water main to boilers.

Connections of proper size to be made from the 3-inch pipe to steam pump and injector, and thence to main feed pipe of boilers direct, and also to feed-water heater, and from the latter to main feed pipe. The feed-water heater is located as shown in blue print.

The boiler feed pipe is of 3 inches diameter and runs along and above front of boilers, and must be suitably supported and connected with feed pipe of each boiler.

The feed pipes to boilers are $1\frac{1}{4}$ inches diameter, as stated previously, and must be provided each with a $1\frac{1}{4}$-inch brass feed valve and a $1\frac{1}{4}$-inch brass check valve of Fairbanks Company's manufacture.

Feed valves to be located or arranged for convenient handling from floor of boiler house.

All feed-pipe connections to be complete and so arranged that boilers may be filled from main water supply direct, and fed by either pump or injector, and by forcing water through feed-water heater, or direct from pump or injector to boilers.

The 6-inch water main in the northwest corner of the boiler-house is

provided with a 4-inch stop valve near the floor. To this valve is attached at present a 3-inch feed pipe, leading to injector, pump, and feed-water heater. This 3-inch pipe will be detached at the 4-inch valve, and a 4-inch galvanized wrought-iron pipe will be connected to the valve, and carried by means of suitable fittings close to the north wall, thence along same in an easterly direction, and below the height of the window sills to a point approximately in line with the west side of the chimney, then rise up to the under side of the girders supporting flues. At a suitable point opposite the feed-water heater now in operation the 4-inch pipe will terminate and form two branches of 3-inch galvanized pipes, one of which is to be connected with the 3-inch feed pipe of the present steam plant, while the other branch will run in a southerly direction to the new steam plant. Each branch must be provided with a 3-inch brass valve near the point where they connect with the 4-inch pipe. All these 4 and 3 inch pipes must be properly hung or otherwise stayed in a satisfactory manner, and all parts must be properly dripped. Three 1-inch brass water-cocks threaded for rubber-hose attachment will be provided and located as directed, in the feed-water pipes.

All connections for this purpose must be carefully laid out and provided with all necessary valves, cocks, drips, etc.

All feed pipes from supply pipe to pump and injector to be lap-welded wrought-iron pipes; all other feed pipes to be of seamless drawn brass pipes. All piping to be properly stayed and secured.

All drip pipes from gauge cocks to lead into a heavy cast-iron tank, 4 feet square by 2 feet deep, which is to be placed between the new and the existing boiler plants, in line with west end of iron floor plates. The top of this tank is to be formed of a heavy cast-iron dished cover, perforated, and must be well supported to resist travel of coal carts over it. The top of tank to be at a suitable height to drain the entire floor in front of boilers through the cover. All drip pipes on forward end of boilers must lead into this box near the top. A 6-inch nozzle must be provided on west side of box, at which a 6-inch piece of iron pipe must be attached. Connections must be made between this pipe and the 8-inch drain outside of the building by means of 6-inch vitrified pipes, as shown in blue print.

Drip pipes from front end of existing boilers must be also connected with the cast-iron box by the contractor without extra compensation.

Steam pipes.—A cast-iron main steam pipe of 12 inches internal diameter must be located above top of boilers, as indicated on blue print. Thickness of metal of this pipe to be $1\frac{1}{4}$ inches; one end of this pipe must be connected with the steam pipe of the present boiler plant, and a 12-inch valve must be interposed at the point of junction. The other must be provided with a 6-inch flanged nozzle and a 6-inch stop valve, all as indicated in blue print. Pipe must be supported on rollers, resting on a cast-iron plate, where passing through wall to engines. Pipe to have three 6-inch flanged nozzles at the bottom and one 8-inch nozzle at side toward engine room. An 8-inch pipe must join at the latter nozzle and, passing through partition wall between boiler and engine room, must be carried to engine cylinders. This pipe to have a pitch toward boilers. The three nozzles at bottom of main steam pipe to be located so as to correspond with centers of boilers, and must be connected with steam stop valves of boilers by means of 6-inch copper pipes of S form, having brass flanges and to be of ample thickness. All connections must be steam tight; all steam pipes to be covered with sectional covering, magnesia covering, or equal.

Pump and injector.—There must be provided also a first-class independent steam-boiler feed pump and one first-class injector, each of ample capacity for 500 horse power of boilers, suitably located, erected and connected with water and steam in boiler house. Koerting universal tube injector preferred. State kind and size of pump and injector. State also kind and maker of valves. Same must be of the best kind. The boilers must be set in place with all connections and fixtures, castings, or ironwork of any description necessary for the proper setting of the boilers complete. Boilers must be delivered in complete working order with steam on. All material and workmanship to be subjected to inspection, and anything not of proper quality or construction may be rejected by the commanding officer.

The boilers must be set in brick masonry, as indicated in blue print, by competent mechanics. Intermediate walls to have a 1-inch hollow space in center, as shown. All parts of masonry and flues exposed to flames or gases to be lined with No. 1 fire brick, laid in best fire clay and fire sand, and properly banded to walls. Boilers, their connections and setting, will be subjected to a rigid inspection and tests. The former will be examined externally and internally by the inspector, and tested before leaving the shop of the maker with a warm-water pressure of 170 pounds per square inch. Working pressure of boilers to be 100 pounds per square inch. Bidder must submit drawings of setting, front, etc.

Cast-iron floor plates, not less than 4 feet wide, made in suitable sections, must be furnished and laid along entire front of boilers.

All iron work of boiler fronts, flues, pipes, etc., not otherwise covered or in furnaces, will be nicely painted black.

There must be also furnished—

One crescent steam tube cleaner, and provisions for connecting it properly with steam for use must be made.

One Christoffel's elliptic-spring steel adjustable tube-scraper for 3½-inch tubes, fitted up for use.

For each boiler, one hoe, one rake, and one slice bar.

(4904–'92.)

APPENDIX 20.

SPECIFICATIONS FOR APPLIANCES FOR THE TRANSMISSION OF POWER (EXCLUSIVE OF LEATHER BELTING) FOR THE SOUTH WING OF THE ARMY GUN FACTORY AT WATERVLIET ARSENAL, WEST TROY, N. Y.

The power transmission comprises a series of line shafts and single shafts, together with all pulleys, couplings, bearings, as shown on the accompanying plates Nos. 1 to 4, and described in these specifications and in pulley list, and all other appurtenances required for the completion of the plant in running order.

Shafts.—All shafts must be made of best selected homogeneous steel of not less than 55,000 pounds tensile strength per square inch of section, unless otherwise specified. They must be turned and polished very accurately to gauge within $\frac{1}{100}$ of one inch, and must be perfectly straight.

Shafts of 5 inches diameter and less to be from rolled material, and shafts over 5 inches diameter to be of forged steel. All shafts to be free from seams or flaws. Shafts to be key-seated for pulleys and couplings wherever required.

Couplings.—All couplings must be of ample length and secure shafts firmly, and should be of such a nature as to insure the same strength and rigidity at the joint as in any part of the shafts.

Couplings, if *plate couplings*, must have stout hubs, must be carefully bored and key-seated, and forced on shaft with not less than 15 tons pressure.

Keys must be parallel, fitting sideways, not top and bottom. Rim to be flanged. Diameter and also length of plate couplings must not be less than four times the diameter of shaft.

Each coupling to be provided with not less than five turned taper bolts, carefully fitted into reamed holes.

Couplings, *if compression or clamp couplings*, must be of ample dimensions to bring to bear a powerful grip on the shaft.

State type of coupling on which bid is based. Reducing couplings must be used where shafts of different diameters are to be united; ends of larger shafts must not be turned down.

Hangers and pillow blocks.—All hangers and pillow blocks to be adjustable and of ball-and-socket pattern. Hanger frame must be strong, bottom parting.

Bearings must be of ample size in all cases, unless a reduced length be fixed by available space. They must be bored and fitted to shaft whether babbitted or not. Babbitted bearings preferred.

Babbitt lining must not be less than $\frac{1}{8}$ inch thick on diameters of 3 inches and below, and shall be $\frac{1}{16}$ inch thicker, on diameters above 3 inches, for each additional inch in diameter. Ends of boxes to be faced.

Cap to be provided with two spacious grease boxes with covers. These grease boxes to be large enough to admit the use of lubricating candles. Oil dishes to be provided. Self-oiling bearings are preferred. All pillow blocks and hangers to be secured to shafting bridges by screw bolts of ample length. All bolts, washers, etc., are required to be furnished by the contractor.

Collars.—Each line shaft and single shaft must be provided with one pair of split or clamp collars, fitted to one of the bearings only, to prevent end motion. They should be placed in the middle of each line shaft over 50 feet in length; on shorter shafts they may be placed on one end.

Pulleys.—All pulleys required are shown in plates 1 to 4, and the accompanying pulley list gives their number, size, and kind. All pulleys to be properly balanced, to have strong hubs, arms, and rims, and faces to be smoothly turned.

Arms to be straight. Pulleys which are to carry double belts must be made heavier and stronger than those that carry only single belts.

In the case of keyed pulleys the key seats must be straight, not taper; the key is let into the shaft, the pulley pushed over it and held in place by the set screws.

All pulleys carrying belts 12 inches wide and over, and also all pulleys, which are not split pulleys, must have clamp hubs, which must be bored small enough to have a forcing fit on the shaft previous to tightening up the hub bolts. All split pulleys must have clamp hubs; the rims of all split pulleys below 24 inches diameter to have sawed, not broken, joints. The hubs of loose pulleys to be longer than the width of the face of the pulley. Edges of rims of tight and loose pulleys must be kept apart by a proper arrangement of their hubs. Loose pulleys to have proper oiling devices.

Friction couplings.—All friction couplings must be rim frictions, "Hill," or equal.

They must be composed of an iron ring, cast with a heavy hub and arms, which is keyed to the end of one shaft, and friction-clutch mechanism keyed to the end of the other shaft. The frame of the clutch mechanism must be one casting, with heavy hub and radial arms, which have strengthening webs between them.

These arms must be provided at the outer ends with pairs of iron jaws which have a radial motion and are operated by a system of three levers, changing the lateral motion of the sliding collar on the shaft into a radial motion, causing the jaws to grip the clutch ring. This must be done gradually, causing the dead shaft to work gradually up to the proper speed, or more quickly if desired.

The iron jaws must be fitted with well seasoned maple shoes.

All parts of the clutches must be made to gauge and perfectly interchangeable, in case parts are to be replaced.

The wooden shoes, if worn out, must be arranged to be readily replaced.

Only the best materials and workmanship must be used, and the clutches must be well balanced and nicely finished.

The shifters must be conveniently located for immediate use.

Friction clutch pulleys ("Hill," or equal).—The clutch mechanism to be similar to that of the friction clutches.

The pulleys themselves must be made with a clutch-ring cast on the pulley arms, which ring is engaged by the clutch.

The pulleys must be bushed with an interchangeable split sleeve or bushing, which, when worn, should be removed and replaced with a

new sleeve, without taking the pulley off the shaft. These pulleys must be perfectly balanced, turned and nicely finished, and fitted with automatic grease cups. The following is a list of the work to be furnished:

A. *Driving shaft.*—This shaft with bearings and pillow blocks is already in place, as shown in blue print, plate 1; it is therefore not to be furnished. But two pulleys, marked 1 and 1*a*, must be furnished and put on the shaft by the contractor, who has to cut also key ways for the pulleys in the shaft. The shaft has $5\frac{15}{16}$ inches diameter. The two pulleys 1 and 1*a* to have 84 inches diameter by 36 inches face, to be heavy, with double arms, and of proper dimensions for a 33-inch heavy double belt. Speed of shaft, 150 revolutions per minute.

A_1. *Intermediate driving counter.*—This shaft has $5\frac{15}{16}$ inches diameter and is 14 feet long over all. It is supported by three adjustable pillow blocks, mounted on a wooden bridge, and carries two heavy plain double-arm pulleys of 84 inches diameter by 36 inches face, of proper dimensions for a 33-inch double belt, and one pulley of 66 inches diameter by 20 inches face, for heavy double belt. Speed of shaft is 150 revolutions per minute; location of shaft in building and pulleys on shaft must be as shown and figured. Bids will be received for this shaft of wrought iron or steel.

A_2. *Underground driving shaft.*—This shaft has a total length of 103 feet 2 inches, and comprises two distinct shafts, united by a friction coupling. The middle part has $5\frac{15}{16}$ inches diameter and a length of about 91 feet 10 inches. Bids will be received for this shaft of wrought iron or steel. Shaft must be made in lengths as figured, connected by flange or plate couplings, supported by twelve pillow blocks, and provided with a plain pulley near west end and a friction pulley near east end. Pulley on west side to be 84 inches diameter by 36 inches face for a 33-inch double belt and to have double arms. Friction clutch pulley on east side to have 60 inches diameter by 22 inches face, for a 20-inch double belt. Friction clutch to have 40 inches diameter. The part of shaft "A_2" on east end has $4\frac{7}{16}$ inches diameter, and is about 11 feet 4 inches long. It is supported by three pillow blocks, and connected to the main shaft by means of a 40-inch six arm friction-clutch coupling capable of transmitting 150 horse-power at 150 revolutions per minute. This shaft carries a plain pulley of 64 inches diameter by 22 inches face, for heavy double belt. Speed of underground driving shaft, 150 revolutions per minute. All pillow-blocks of this shaft must be babbitted and provided with pedestal-base plates of proper dimensions, to rest on masonry. The masonry supports have been erected by the Ordnance Department, and the foundation bolts for pedestal base plates have been located as shown in blue print.

A_3. *Underground idler.*—The diameter of this shaft is $4\frac{7}{16}$ inches; its length is 4 feet 2 inches. Both ends are necked down to a diameter of $3\frac{7}{16}$ inches for boxes of pillow blocks. Care must be taken in limiting length of box toward wall to suit size and location of shaft.

Pillow blocks must be provided with base plates and similarly mounted as those of shaft "A_2."

This shaft carries a plain double arm pulley of 64 inches diameter by 22 inches face for a double belt.

B. *Overhead idler.*—This shaft has a diameter of $4\frac{7}{16}$ inches and is 5 feet 2 inches long. The ends are necked down to $3\frac{7}{16}$ inches diameter for drop hanger bearings; drop hangers, 27 inches drop, to be mounted on wooden bridge.

The shaft carries a plain double arm pulley of 64 inches diameter by 22 inches face for a double belt.

B_1. *Overhead counter, east.*—This shaft has $4\frac{7}{16}$ inches diameter and is 9 feet 4 inches long.

It is supported by three drop hangers, 27 inches drop, mounted on wooden bridge, and carries one plain double-arm pulley of 64 inches diameter by 22 inches face, and one plain double-arm pulley of 48 inches diameter by 26 inches face for 20 and 24 inch double belts, respectively. Speed of shaft, 150 revolutions per minute.

B_2. *Line shaft, east.*—Total length of this shaft is 387 feet. It must be made in twenty-two lengths, as follows:

1 length of 8 feet 6 inches 3 lengths of 18 feet 0 inch.	—$4\frac{7}{16}$ inches diameter.
3 lengths of 18 feet 0 inch	—$4\frac{3}{16}$ inches diameter.
3 lengths of 18 feet 0 inch	—$3\frac{15}{16}$ inches diameter.
3 lengths of 18 feet 0 inch	—$3\frac{11}{16}$ inches diameter.
3 lengths of 18 feet 0 inch	—$3\frac{7}{16}$ inches diameter.
1 length of 18 feet 0 inch	—$3\frac{3}{16}$ inches diameter.
3 lengths of 18 feet 6 inch	—$2\frac{15}{16}$ inches diameter.
1 length of 18 feet 0 inch	—$2\frac{11}{16}$ inches diameter.
1 length of 18 feet 6 inches	—$2\frac{7}{16}$ inches diameter.

It must be supported by 45 pillow-blocks, as follows:

8 pillow blocks for $4\frac{7}{16}$ inch shafts.
6 pillow blocks for $4\frac{3}{16}$ inch shafts.
6 pillow blocks for $3\frac{15}{16}$ inch shafts.
6 pillow blocks for $3\frac{7}{16}$ inch shafts.
2 pillow blocks for $3\frac{3}{16}$ inch shafts.
6 pillow blocks for $2\frac{15}{16}$ inch shafts.
2 pillow blocks for $2\frac{11}{16}$ icnh shafts.
2 pillow blocks for $2\frac{7}{16}$ inch shafts.

Forty-nine pulleys, Nos. 12 to 60, inclusive, must be fitted to the shaft, one of which for double belt, it is to be plain with double arms and clamp hub; all other pulleys are split pulleys for light double or single belts. For details see pulley list. Location of shaft in building, also location of couplings, bearings, and pulleys are shown in drawings. Speed of shaft is 120 revolutions per minute.

C. *Intermediate drill counter.*—This shaft has $2\frac{3}{16}$ inches diameter and is 6 feet long. It must be supported by two drop hangers, drop 16 inches, and two pulleys, Nos. 61 and 62, must be fitted on it. For details see pulley list.

C_1. *Intermediate drill counter.*—This shaft has $2\frac{3}{16}$ inches diameter and is 4 feet 3 inches long. It must be supported by two drop hangers, drop 16 inches, and two pulleys, Nos. 63 and 64, must be fitted on it. For details see pulley list.

C_2. *Intermediate drill counter.*—This shaft has $2\frac{3}{16}$ inches diameter and is 3 feet 6 inches long. It must be supported by two drop hangers, drop 16 inches, and two pulleys, Nos. 65 and 66, must be fitted on it. For details see pulley list.

C_3. *Intermediate drill counter.*—This shaft has $2\frac{3}{16}$ inches diameter and is 11 feet long. It must be supported by three drop hangers, drop 24 inches, and two pulleys, Nos. 67 and 68, must be fitted on it. For details see pulley list.

C_4. *Intermediate counter for threading and slotting machine.*—This shaft has $2\frac{7}{16}$ inches diameter and is 10 feet 9 inches long. It must be supported by three drop hangers, drop 21 inches, and three pulleys, Nos. 69 to 71, must be fitted to it. For details see pulley list.

A_4. *Intermediate gallery counter.*—This shaft has $4\frac{7}{16}$ inches diameter and is 7 feet 9 inches long. It must be supported by two inverted

hangers, 22 inches high, and two plain double-arm pulleys for double belts, Nos. 6*a* and 6*d*, must be fitted to it. For details see pulley list.

A_5. *Idler.*—This shaft has a diameter of $3\frac{15}{16}$ inches and is 5 feet 6 inches long. It must be supported by two inverted hangers, 16 inches high, and one plain double-arm pulley, No. 6*c*, for double belts, must be fitted to it. For details see pulley list.

A_6. *Idler.*—This shaft has a diameter of $3\frac{15}{16}$ inches and is 5 feet 6 inches long. It must be supported by two drop-hangers, 14 inches drop, and one plain double-arm pulley, No. 6*d*, for double belt, must be fitted to it. For details see pulley list.

Gallery drive, east.—This drive comprises shafts D to D_6 inclusive. Location and details of the shafts are shown in the drawings; the details of pulleys in the pulley list. Speed of shafts is 120 revolutions per minute.

D. *First gallery counter, east.*—Diameter of shaft, $4\frac{15}{16}$ inches, length 14 feet 9 inches. This shaft must be supported by three pillow blocks, and fitted with six plain pulleys with clamp hubs, for double belts, Nos. 72 to 77, inclusive. Pulleys Nos. 73 and 74 have double arms, the others single arms.

D_1. *Second gallery counter, east.*—Diameter of shaft, $4\frac{15}{16}$ inches; length, 14 feet 9 inches. This shaft must be supported by three pillow blocks, and fitted with six plain pulleys with clamp hubs for double belts, Nos. 78 to 83, inclusive. Pulleys Nos. 79 and 80 have double arms, the others single arms.

D_2. *Third gallery counter, east.*—Diameter of shaft, $4\frac{11}{16}$ inches; length, 14 feet 9 inches. This shaft must be supported by three pillow blocks, and fitted with six plain pulleys with clamp hubs for double belts, Nos. 84 to 89, inclusive. Pulleys Nos. 85 and 86 have double arms, the others single arms.

D_3. *Fourth gallery counter, east.*—Diameter of shaft, $4\frac{11}{16}$ inches; length, 14 feet 9 inches. This shaft must be supported by three pillow blocks, and fitted with six plain pulleys with clamp hubs for double belts, Nos. 90 to 95, inclusive. Pulleys Nos. 91 and 92 have double arms, the others single arms.

D_4. *Fifth gallery counter, east.*—Diameter of shaft, $4\frac{7}{16}$ inches; length, 14 feet 9 inches. This shaft must be supported by three pillow blocks, and fitted with six plain pulleys with clamp hubs for double belts, Nos. 96 to 101, inclusive. Pulleys Nos. 97 and 98 have double arms, the others single arms.

D_5. *Sixth gallery counter, east.*—Diameter of shaft, $4\frac{7}{16}$ inches; length, 14 feet 9 inches. This shaft must be supported by three pillow blocks, and fitted with six plain pulleys with clamp hubs for double belts, Nos. 102 to 107, inclusive. Pulleys Nos. 103 and 104 have double arms, the others single arms.

D_6. *Seventh gallery counter, east.*—Diameter of shaft, $4\frac{7}{16}$ inches; length, 11 feet. This shaft must be supported by three pillow blocks, and fitted with three plain pulleys with clamp hubs for double belts, Nos. 108 to 110, inclusive. Pulleys Nos. 108 and 109 to have double arms, No. 110 single arms.

E. *Driving counter, west.*—This shaft has $4\frac{15}{16}$ inches diameter and is 11 feet 9 inches long. It must be supported by three pillow blocks and two plain pulleys with clamp hubs for double belts, Nos. 111 and 112, and one split pulley for single belt, No. 175, must be fitted to it. For details see pulley list. Speed of shaft, 120 revolutions per minute.

F. *Gallery shaft, west.*—This shaft has $4\frac{15}{16}$ inches diameter and is 11 feet 9 inches long. It must be supported by three pillow blocks, and

five plain pulleys with clamp hubs, Nos. 113 to 117, inclusive, must be fitted to it. Pulleys Nos. 113 and 114 are for double belts, and pulleys Nos. 115 to 117 for single belts. For details see pulley list. Speed of shaft, 120 revolutions per minute.

G. *First line shaft, west.*—This shaft has a total length of 38 feet 7 inches. It comprises three lengths: One of $4\frac{1}{16}$ inches diameter, and two lengths of $3\frac{7}{16}$ inches diameter. It must be supported by seven pillow blocks, two of which are $4\frac{1}{16}$ inches, and five for $3\frac{7}{16}$-inch shafts. Ten pulleys, Nos. 118 to 125, inclusive, and Nos. 173 and 174 must be fitted to it. Pulleys Nos. 118, 119, and 123 are plain, with clamp hubs for double belts. Pulleys Nos. 121, 173, and 174 are plain, with clamp hubs for single belts. Pulley No. 122 runs loose on shaft, and pulleys Nos. 120, 124, and 125 are split pulleys for single belts. For details see pulley list. Speed of shaft, 120 revolutions per minute.

H. *Second line shaft, west.*—This shaft has a total length of 30 feet 6 inches and a diameter of $2\frac{7}{16}$ inches. It comprises two lengths. It must be supported by five drop-hangers, 30 inches drop, and four pulleys for single belts, Nos. 126 to 129, inclusive, must be fitted to it. Pulleys Nos. 127 and 129 are plain, with clamp hubs; No. 128 is a split pulley, and pulley No. 126 runs loose on the shaft. For details see pulley list. Speed of shaft, 120 revolutions per minute.

I. *Third line shaft, west.*—This shaft has a diameter of $2\frac{15}{16}$ inches and a total length of 35 feet 4 inches. It comprises two lengths. It must be supported by five drop-hangers, 20 inches drop, and five plain pulleys, with clamp hubs, Nos. 130 to 134, inclusive, must be fitted to it. Pulley No. 130 is for double belt, the other pulleys for single belts. For details see pulley list. Speed of shaft, 120 revolutions per minute.

L. *Fourth line shaft, west.*—This shaft has a total length of 38 feet 6 inches. It comprises two lengths; one of $4\frac{7}{16}$ inches diameter and one of $2\frac{15}{16}$ inches diameter. The latter may be furnished in two shorter lengths if more convenient to the maker. It must be supported by seven pillow blocks, three for $4\frac{7}{16}$ and four for $2\frac{15}{16}$-inch shafts. Eight pulleys, Nos. 137 to 144, inclusive, must be fitted to it. Pulleys Nos. 137 to 140, inclusive, are plain, with clamp hubs; Nos. 137 and 138 for double belts, and Nos. 139 and 140 for single belts. Pulleys Nos. 141 to 144, inclusive, are split, with clamp hubs for single belts. For details see pulley list. Speed of shaft, 120 revolutions per minute.

O. *Fifth line shaft, west.*—This shaft has a total length of 38 feet 6 inches. It comprises two lengths, one of $4\frac{3}{16}$ inches diameter and one of $2\frac{15}{16}$ inches diameter. The latter may be furnished in two shorter lengths if more convenient to the maker. It must be supported by seven pillow blocks, three for $4\frac{3}{16}$-inch, and four for $2\frac{15}{16}$-inch shafts. Ten pulleys must be fitted to this shaft, Nos. 149 to 158, inclusive. Pulleys Nos. 149 and 150 are plain, with clamp hubs for double belts. Pulleys Nos. 151 and 152 are plain, with clamp hubs for single belts. Pulleys Nos. 153 to 158, inclusive, are split pulleys, with clamp hubs for single belts. For details see pulley list. Speed of shaft, 120 revolutions per minute.

S. *Sixth line shaft, west.*—This shaft has a total length of 38 feet 6 inches. It comprises two lengths, one of $3\frac{15}{16}$ inches and one of $2\frac{15}{16}$ inches diameter. The latter may be furnished in two shorter lengths if more convenient to the maker. It must be supported by seven pillow blocks, three for $3\frac{15}{16}$-inch, and four for $2\frac{15}{16}$-inch shafts. Six pulleys, Nos. 163 to 168, inclusive, must be fitted to it. Pulleys Nos. 163 and 164 are plain pulleys, with clamp hubs for double belts; Nos. 165 and 166 are plain, with clamp hubs for single belts. Pulleys Nos. 167 and 168

are split pulleys, with clamp hubs for single belts. For details see pulley list. Speed of shaft, 120 revolutions per minute.

U. *Seventh line shaft, west.*—This shaft has a total length of 38 feet 6 inches. It comprises two lengths, one of $3\frac{11}{16}$ inches diameter and one of $2\frac{15}{16}$ inches diameter. The latter may be furnished in two shorter lengths if more convenient to the maker. It must be supported by seven pillow blocks, three for $3\frac{15}{16}$-inch and four for $2\frac{15}{16}$-inch shafts. Two plain pulleys with clamp hubs, No. 171, for double belt, and No. 172, for single belt, must be fitted to it. For details see pulley list. Speed of shaft, 120 revolutions per minute.

Pulleys for boring bar counters.—There must be furnished six pairs of tight and loose pulleys, Nos. 135, 136, 145 to 148, 159 to 162, 169, and 170. For details see pulley list. These pulleys are plain for single belts. The pulleys must be bored exact to gauge for $2\frac{15}{16}$-inch shafts. Gauge will be furnished by the Department. The boring bar counters K. M. N. P. R. T. will not be furnished under these specifications, and the above pulleys will be put on them by the Department.

The whole work must be erected by the contractor on supports provided by the Ordnance Department.

The underground shafts, A_2 and A_3, will be erected on masonry foundations. All other shafts, etc., will be erected on wooden supports of about 12 inches thickness. All bolts for securing pillow blocks or hangers to supports must be through-bolts of ample length. Washers under all heads and nuts, those resting on wood to be of cast iron, not less than 3 inches in diameter, and of ample thickness. All shafts must be in perfect alignment. All holes in metal or wood required for the erection of any part of the whole work must be made by the contractor. He must provide all skilled and unskilled labor, and all materials and tools, also all appliances for transporting, moving, and hoisting of his work, and for its complete erection, in running order, ready for belting.

Dimensions figured on the drawings are to be followed in all cases in preference to scale measures, and the wording of the specification takes precedence over both.

The drawings, the pulley list, and the specifications are intended to be alike in every respect; but any work shown or specified in one of them and not particularly shown or described in the others, and any work evidently necessary to the completion of the whole work as specified or shown, is to be done by the contractor, without extra charge, the same as if it were shown or specified.

The contractor is to comply with the State or other laws, and is liable for all penalties and all damages to life and limb that may occur owing to his negligence, or that of his employés, during the erection of the whole work. The commanding officer will give, on demand, such interpretations, either verbally or by writing or drawings, as in his judgment the nature of the work may require, having particular care that any and all work done, and materials used for the work, be such as specified. He will determine the amount of damages which may occur from any cause, and decide upon the fitness of all material used and work done.

Railroad tracks, connecting with the tracks of the Delaware and Hudson Railroad Company, run into the gun factory building. Bids must be made for the whole work, erected in place in complete running order, ready for belts, in the Army Gun Factory, Watervliet Arsenal, West Troy, N. Y. Bidders will state shortest time for the delivery and erection from the date of award of contract, as time will be a considera-

tion in the acceptance of the bid. If any delay occurs in the completion of the work, in perfect running order, beyond the date specified in the contract, a reduction shall be made in the contract price thereof of $20 per day for each and every day (excepting Sundays) after said date until the completion of the work.

Payments will be made in two installments of 50 per cent each. The first payment to be made on the complete erection of the work in place, and the second upon the final acceptance of the whole work by the United States, after a continuous successful operation of the plant of twenty working days, but in no case later than sixty days after the complete erection of the same.

(4904–'92.)

APPENDIX 21.

SPECIFICATIONS FOR BELTING FOR THE ARMY GUN FACTORY AT THE WATERVLIET ARSENAL, WEST TROY, N. Y.

The following is a list of belting required:

Item 1.—Heavy double belt.

One belt 33 inches wide, pulleys 84 and 84 inches diameter, 40½ feet between centers.

One belt 33 inches wide, pulleys 84 and 84 inches diameter, 35 feet between centers.

One belt 33 inches wide, pulleys 84 and 84 inches diameter, 29 feet between centers.

Item 2.—Double belts.

One belt 24 inches wide, pulleys 48 and 60 inches diameter, 9½ feet between centers.

One belt 22 inches wide, pulleys 48 and 60 inches diameter, 26 feet between centers.

Two belts 21 inches wide, pulleys 54 and 54 inches diameter, each 36 feet between centers.

Two belts 20 inches wide, pulleys 54 and 54 inches diameter, each 36 feet between centers.

Two belts 18 inches wide, pulleys 54 and 54 inches diameter, each 36 feet between centers.

*One belt 20 inches wide, running over 4 pulleys, 2 tight and 2 loose, in driving 2 shafts at right angle to each other. Pulleys 64 inches diameter, 17½ feet between centers. Total length of belt about 105 feet.

*One belt 20 inches wide, running over 4 pulleys, 2 on line shafts and 2 on idlers. Diameter of line-shaft pulleys 60 inches, diameter of idler pulleys 66 inches and 36 inches. Total length of belt about 102 feet.

One belt 18 inches wide, pulleys 68 and 84 inches diameter, 39½ feet between centers.

Two belts 18 inches wide, pulleys 66 and 66 inches diameter, each 36 feet between centers.

Two belts 16 inches wide, pulleys 66 and 66 inches diameter, each 36 feet between centers.

Two belts 15 inches wide, pulleys 66 and 66 inches diameter, each 36 feet between centers.

Item 3.—Double belting.

45 running feet 10 inches wide.
230 running feet 8 inches wide.
100 running feet 6 inches wide.

Item 4.—Light double belting.

1,080 running feet, 5 inches wide.
350 running feet, 4½ inches wide.
640 running feet, 4 inches wide.
450 running feet, 3½ inches wide.
150 running feet, 3 inches wide.
190 running feet, 2½ inches wide.

Item 5.—Single belting.

310 running feet, 4½ inches wide.
195 running feet, 4 inches wide.
413 running feet, 3½ inches wide.
400 running feet, 3 inches wide.
175 running feet, 2½ inches wide.

All belts enumerated may be of oak-tanned leather belting, fulled leather belting, cotton leather belting, or any other kind of belting; but the quality of any belting as to wear and driving power must not be inferior to that respectively of heavy double, and double, and single oak-tanned leather belting. All belts under items 1 and 2 must be put on pulleys endless by the contractor; those for which no length is given, have stated diameters of pulleys and their distances.

The two belts marked thus * are to run on both sides over pulleys. All belting is to be delivered at the Watervliet Arsenal, West Troy, N. Y. All belts must be guaranteed to run straight and give entire satisfaction for work required.

All oak-tanned leather used in belting must be pure center stock, from which shoulders and blanks are entirely removed, free from brands, cuts, or other imperfections, strictly short lap, each piece not to exceed 4 feet 3 inches in length, even in heft, and not containing any splits or fillings. All oak-tanned belting should be made without any rivets or pegs.

The contractor will furnish all the materials, tools, and appliances; also all skilled and unskilled labor for handling and putting on the belts.

He is to comply with the State and other laws, and will be responsible for all injury or loss of life and limb to his employés; also for all damages caused by his own negligence or that of his employés.

Bids will be received for any kind of belting of superior quality and established reputation.

Bids must be made for each item separately, and bidder will state also price for which additional quantities of any of the belting will be furnished by him.

The time for the delivery and completion of the work will be stated in bid. If any delay occurs in the completion of the work, in perfect running order, beyond the date specified in the contract, a reduction shall be made in the contract price thereof of $10 per day for each and every day (excepting Sundays) after said date until the completion of the work. Payments will be made in two installments of 75 and 25 per cent each; the first one upon the delivery of all belting in the gun factory building and its acceptance by the commanding officer, and the second of 25 per cent after all belts have been put on pulleys, endless, which have been designated thus in these specifications, and after a successful continuous run of such belting for ten days, but in no case later than sixty days after their delivery and erection by the contractor.

APPENDIX 22.

SPECIFICATIONS FOR ONE SIX-WHEEL SWITCHING LOCOMOTIVE ENGINE FOR THE WATERVLIET ARSENAL, WEST TROY, N. Y.

GENERAL DESCRIPTION.

Gauge.—4 feet 8½ inches.
Fuel.—Bituminous coal.
Cylinders.—About 19 inches diameter by 24-inch stroke.
Diameter of driving wheels.—About 50 inches.
Driving wheel—Base: About 11 feet.
Total wheel—Base: About 11 feet.
Weight on drivers in full working order.—About 105,000 pounds.
Total weight of engine.—About 105,000 pounds.
General design shown by blue print appended.
The engine shall have a capacity to pull about 3,500 gross tons on a level, and to run in a curve of 150 feet radius.

CONSTRUCTION.

Boiler.—To be of the best workmanship and material, to be capable of carrying with safety a working pressure of 140 pounds per square inch, and of sufficient capacity to supply steam economically. All horizontal seams quadruple riveted with welt strips inside. A double riveted seam uniting waist with fire box. All plates planed at edges and calked with round pointed tool.

Boiler to have extended front end.

Waist, dome, and outside of fire box of Spang steel $\frac{7}{16}$ inch thick. Diameter of waist at front end 54 inches, made straight with one dome, 30 inches diameter placed on waist.

Fire box.—Of Spang steel, 84 inches long, 33⅞ inches wide, front 54½ inches, back 51½ inches deep. Crown sheet three-eighths, tube sheet one-half, side and back sheets five-sixteenths thick. Water-space 4 inches front, 3 inches sides, and 3 inches back. All sheets thoroughly annealed after flanging.

Stay bolts seven-eighths inch diameter, screwed and riveted to sheets, and placed not over four and one-half inches from center to center.

Crown sheets supported by crown-bars made of two pieces of wrought iron, 5 inches wide, ¾ inch thick, placed not over four and one-half inches apart, reaching across crown and resting on edge of side sheets.

Crown bars riveted to crown-sheets with seven-eighths inch rivets placed not over four and one-half inches from center to center, each bar having two stay-braces to top of boiler or dome.

Tubes.—Of charcoal iron No. 13 W.G., 190 in number, 2 inches diameter, 11 feet in length. Set with copper ferrules at both ends.

Cleaning holes.—At corners of fire box, and blow-off cock on front.

Grate.—Rocking bars with drop plate. Ash pan with dampers front and back.

Stack.—Smokestack straight; deflecting plate and netting in smoke box.

Frames.—Of best hammered iron, main frame in one section with braces welded in. Forward section securely bolted and keyed to main frame.

Pedestals protected from wear by cast-iron shoes and wedges, and locked together at bottom by bolt through cast-iron thimble. Width of main frame 4 inches throughout.

Cylinders.—Of closed-grained, hard charcoal iron. Cast with half saddle attached, the right and left cylinders from the same pattern and interchangeable. Fitted together in a substantial manner and securely bolted and keyed to frame. Valve face and steam chest seat raised above face of cylinder to allow for wear. Cylinders oiled from Nathan sight-feed lubricator placed in cab, with copper pipe under boiler lagging to steam chest.

Throttle.—Balanced valve placed in dome, with wrought-iron dry pipe and cast-iron steam pipe connecting to cylinders.

Pistons.—Made with removable follower, and fitted with brass rings babbited and springs, or with approved steam packing. Piston rods of hammered iron.

Valve motion.—Approved shifting link motion graduated to cut-off equally at all points of the stroke. Links, sliding blocks, plates, lifting links, pins, and eccentric-rod jaws of the best hammered iron, thoroughly case hardened.

Guides.—Of hammered iron, case hardened.

Valves.—Richardson balanced steam-chest valves.

Cross heads.—Of cast-steel, with brass gibs.

Driving wheels.—Six in number, 50 inches diameter. Centers of best charcoal iron and turned to 44 inches diameter to receive tire.

Tires.—Of Midvale steel, 3 inches thick, front and back pair flanged, $5\frac{3}{4}$ inches wide; main pair plain, $6\frac{1}{2}$ inches wide.

Axles.—Of hammered iron, with journals $7\frac{1}{2}$ inches diameter, $8\frac{1}{2}$ inches long. Driving boxes of cast iron with heavy brass bearings and large oil cellars.

Springs.—Made of the best cast-steel, tempered in oil. Secured to a system of equalizing beams to insure the engine riding in the best possible manner.

Rods.—Connecting and parallel rods of the best hammered iron, each forged solid, fitted with all necessary straps, keys, bolts, and brasses.

Crank pins.—Of steel.

Water supply.—To have two injectors with well-arranged cocks and valves for convenience in working.

Cab.—Constructed of seasoned ash, substantially built, and secured by joint bolts and corner plates. Furnished with seats and tool boxes for engineer and fireman. Step at each end of engine.

Finish.—Boiler lagged with wood and jacketed with planished iron; secured by planished iron bands. Dome lagged with wood, with sheet-iron casing and cast-iron rings painted. Cylinders lagged with wood, with sheet-iron casing and cast-iron head covers painted. Steam chests cased with sheet iron, with cast-iron covers, painted. Hand rail of iron, painted, with columns secured to boiler or to tank.

Fixtures and furniture.—Engine provided with two sand-boxes, headlight and support for same, bell, whistle, steam gauge, gauge cocks, cab lamp, heater, blower, oil cans, torch, also all necessary wrenches,

fire tools, hammers, chisels, packing tools, etc., two jack screws, and a pinch bar.

All finished, removable nuts case hardened.

All threads United States standard.

Principal parts of engine fitted to gauges and templets and interchangeable.

Tank.—Of 1,200 gallons capacity, strongly put together with angle irons, corners, and thoroughly braced and stayed and well secured to boiler. Tank of saddle-bag form on top of boiler.

Painting.—Engine to be well painted and varnished, with number, mark, or name put on in neat style.

Brakes.—Engine to be furnished with outside equalized steam brake (American) on the three pairs of driving wheels.

Material and workmanship must be first class throughout.

SPECIFICATIONS FOR BOILER AND FIRE-BOX STEEL.

A very careful examination will be made of every sheet, and none will be accepted that shows mechanical defects.

A test strip, taken lengthwise of the sheet and without annealing, should have a tensile strength of 55,000 pounds per square inch and an elongation of 30 per cent in section originally 2 inches long.

Sheets will not be accepted if the test shows a tensile strength less than 50,000 pounds or greater than 65,000 pounds per square inch, nor if the elongation falls below 25 per cent.

Should any sheets develop defects in working they will be rejected.

Bids for locomotives on plans differing from that described in the specifications, but fulfilling the general requirements as to capacity, etc., will receive consideration in making the award.

SPECIFICATIONS FOR ONE RAILWAY CAR FOR TRANSPORTING HEAVY GUNS.

The car, as shown in accompanying drawing, has a capacity of 60 tons. Smallest curve in which car should be able to run has a radius of 150 feet. The platform is 26 feet 9 inches long by 8 feet wide, and is constructed of four longitudinal stringers of I beams 10 inches deep, about 137 pounds per yard; the outer frame is made of channel iron 10 inches high, 106 pounds per yard. The whole frame riveted together by 5-inch by 5-inch angle iron (69 pounds per yard) in all corners. The frame to be stiffened by two diagonal braces 8 inches by $\frac{1}{4}$ inch, riveted on top of beams and channel irons. Top of frame to have a flooring of 2-inch oak planks, secured by $\frac{1}{2}$-inch bolts to channel irons and beams, heads to be countersunk into the wood. Frame to be strengthened by eight truss rods $1\frac{3}{4}$ inches diameter, made of the best wrought-iron, bent and secured as shown in accompanying drawing.

The frame rests on two 7-inch I beams (88 pounds per yard) at each end, with castings on top for truss rods and center casting and side supports underneath, as shown in drawing.

The car to have two 6-wheel trucks, the main frame consisting of two iron plates 1 inch thick, to which are riveted pedestal castings for the journal boxes. The two iron plates are connected together in the center between the journals by a box girder beam. The side plates are also connected at each end by T-irons riveted on.

Axles, 6 in number, to be made of hammered iron, journals to be heavy and substantial and constructed so as to give ample room for springs.

Springs to be heavy enough to be effective when car is loaded with 60 gross tons as a maximum load.

Wheels to be 30 inches in diameter, heavy and substantial enough for a car of this capacity.

Gauge of track 4 feet 8½ inches.

Trucks also to be connected with platform frame by proper safety chains.

Car to be furnished with car-coupling at each end, of approved master car builders' style; also to have brakes on all wheels to be operated by hand, same as on ordinary freight car.

Car to be well painted.

Workmanship and material to be first class throughout.

Bids for car on plans differing from that described in the specifications, but fulfilling the general requirements as to capacity, etc., will receive consideration in making the award.

Bidders will state the time required for the completion and delivery of the locomotive and car in complete working order at the Watervliet Arsenal, West Troy, N. Y.

For any delay in the completion and delivery of the locomotive and car beyond the date specified in the contract, a deduction will be made of $10 in the contract price thereof for each and every day (excepting Sundays) after said date until the completion of the contract.

Payment will be made upon final acceptance of the whole work by the United States, after a successful trial of the locomotive at Watervliet Arsenal.

Should the contractor feel aggrieved at any decision of the commanding officer under these specifications, he shall have the right to appeal to the Chief of Ordnance, U. S. Army, and his decision shall be final.

(4904–'92)

APPENDIX 23.

SPECIFICATIONS FOR GRANITE-BLOCK ROADS AND PAVEMENTS AT THE WATERVLIET ARSENAL, WEST TROY, N. Y.

Some of the roads will be entirely new, while a part are at present paved with stone blocks and flagging. This pavement will be taken up and placed alongside the roads in such a manner as not to impede the traffic of wagons entirely alongside the roads. Such flagging as is in good condition will be used again by the contractor in the construction of the new roads. Any deficiency on good and suitable flagging will be supplied by the Ordnance Department. The stone blocks obtained from existing pavements will be used in repaving or in new pavements, as directed by the commanding officer.

All roadbeds for granite-block pavements must be excavated to a depth of 15 inches below the surface of the finished road. Should there be any spongy material or vegetable matter in the bed thus prepared, it shall be removed and the space filled with fine gravel or broken stone, and carefully rammed so as to make such filling compact and solid.

The entire roadbed, after having been brought to the required subgrade, shall be rolled with a heavy roller weighing not less than 10 tons, until the surface is firm and compact. Parts of the roadbed which can not be reached by the heavy roller shall be tamped or rolled with a smaller roller and sprinkled with water if required.

On the foundation-bed so prepared, which is to be 15 inches below the surface of finished road, must be put a uniform layer, 4 inches higher after rolling, of sound broken stone of approved quality, $2\frac{1}{2}$-inch ring. This must be rolled down till the mass will not yield under the roller.

A sand bed about 3 inches thick is to be prepared on top of the foundation of broken stone. The sand must be clean and sharp, without an admixture of pebbles. Gravel for this material will be found by the contractor on the dock. He has to screen it so as to obtain the quality specified for the sand bed.

On the sand bed so prepared the stone blocks will be laid. The stone blocks are to be of a durable, sound, and uniform quality of granite, each measuring on the face or upper surface not less than 8 inches nor more than 12 inches in length, and not less than 3 inches nor more than 4 inches in width, and not less than 7 inches nor more than 9 inches in depth. Such stone blocks must be split and dressed so as to form, when laid, close and joints, end side joints, not exceeding one-half inch wide top and bottom, with fair and true surfaces on top, bottom, and ends; and they are in all respects to be equal to the specimen blocks deposited with the commanding officer. All stone blocks will be inspected, and any rejected stones shall be removed immediately by

the contractor from the line of the work. The stone blocks must be laid at right angles with the line of the road, except at intersecting roads and in other special cases, when they shall be laid at such angles and with such crown and such grade as will be directed. Each course of blocks shall be of uniform width, and so laid that all longitudinal joints shall be broken by a lap of at least 2 inches, and that all such joints shall be as close as possible.

As the blocks are laid they shall be covered with clean fine sand, which shall be raked until all the joints become filled therewith. The blocks shall then be thoroughly rammed to a firm unyielding bed, with a uniform surface, to conform to the grade and crown of the road. No ramming shall be done within 25 feet of the face of the work that is being laid.

Whenever a suitable length of the road shall have been constructed as above described, it shall be covered with a good and sufficient second coat of clean sharp sand, and shall immediately thereafter be thoroughly rammed until the work is made solid and secure.

The approximate quantity of granite roads and pavements will be between 1,700 and 2,000 square yards; the approximate quantity of flagging to be laid will be 2,500 linear feet. The amount of work to be done may be increased or diminished at the discretion of the commanding officer, in view of funds available for the purpose.

The roads to be constructed or paved can be inspected by bidders at the Watervliet Arsenal. Their extent, width, and grade will be determined by the commanding officer after the award has been made. The grade of all roads will follow, as much as possible, the natural grade of the grounds.

Grade stakes and line stakes will be furnished and set by the Department.

The top level of existing paved roads will be retained in the new roads, except where otherwise directed by the commanding officer, who may also change the line of roads, if this should be, in his opinion, preferable.

Any gravel necessary for the work, in conformity with these specifications, will be furnished, unscreened, along the Hudson River dock by the Department. All flagging to be furnished by the Department will be delivered to the contractor along the line of his work. All flagging to be furnished by the contractor will be of first-class quality, 4 inches thick, some of it 2 feet and some of it 4 feet wide, all in suitable lengths, and bidders will make bids for laying flagging for both widths.

All other materials, also all labor of any kind, and all tools and appliances required for the proper prosecution of the work, must be furnished by the contractor.

All excavated material that is left along the line of the work after its completion will be removed by the Ordnance Department.

Bids will be received as follows:

(1) Price per square yard for taking up existing pavement.

(2) Price per square yard of granite pavement with material furnished by the Ordnance Department.

(3) Price per square yard of granite pavement with granite blocks and broken stone furnished by the contractor.

(4) Price per linear foot for laying flagging with material furnished by the Ordnance Department.

(5) Price per linear foot for laying flagging with flagging furnished by the contractor.

Payment will be made at the completion of the whole work, or in monthly installments at the discretion of the commanding officer.

Bidders will state the time required for the completion of the work.

For any delay in the completion of the entire work beyond the date specified in the contract a deduction will be made of $10 in the contract price thereof for each and every day (excepting Sundays) after said date until the completion of the contract.

Should the contractor feel aggrieved at any decision of the commanding officer under these specifications, he shall have the right to appeal to the Chief of Ordnance, U. S. Army, and his decision shall be final.

(4904–'92.)

APPENDIX 24.

SPECIFICATIONS FOR A STEAM HEATING PLANT FOR SOUTH WING OF THE ARMY GUN FACTORY AT WATERVLIET ARSENAL.

The heating plant comprises a number of steam coils and radiators, arranged as shown on the accompanying blue print, viz:

Fifteen coils marked *a*, each 45 feet long, in east and west aisles on walls, 8 in east aisle and 7 in west aisle.

Twenty-two coils marked *b*, each 6 feet long on main piers of building.

Twenty coils marked *c*, each 15½ feet long on brick piers between main aisle and west aisle.

Twenty-one coils marked *d*, each 36 feet long, in main aisle below floor.

Two coils marked *e*, each 28 feet long, in main aisle on south wall.

One coil marked *f*, 38 feet long, on south wall of west aisle.

All coils must be made of ten 1-inch steam pipes, having manifolds at ends. All coils to be made with necessary provisions to allow for expansion. Each heating coil must be provided with an air valve, a 1½-inch steam supply, and a 1¼-inch drip valve. All valves to be readily accessible from floor to shop.

Valves to be placed as designated, generally above floor or with an extension of handle reaching above floor. With the exception of the coils marked *d*, all coils must be properly supported and secured to walls by means of wooden battens and hook plates, the latter to be made of sheet-steel. The lowest pipe of all these coils should be about 12 inches above floor line.

Any connections between coils and supply and drip pipes must be made so as to be easily broken in case any coil should need to be removed temporarily at any time. The coils marked *d* will be placed beneath the floor and are to lay horizontally, *i. e.*, the pipes forming the coils lay generally in a plane parallel to the floor. The highest point of these coils will be 6 inches below the floor line, and care must be taken to drain these coils properly.

These coils must be constructed similarly as all others, except that only nine of the pipes of each coil are joined in the manifold at the feed end, while the tenth pipe is to form the drip-pipe of each coil. The pipes must be properly spaced by an adequate number of ring-plates or otherwise, in approved manner. The steam-supply valves, as well as the drip-valves of all coils *c*, must be arranged on or near the main piers of the building, and must be put in place properly connected with the whole heating system of the building, while the coils *d* proper, including hook plates and valves and the connections from their terminals to their feed and drip valves, which can not be put in place now, must be furnished complete, coils and connections marked and wired together, and deposited at such places in the shop as may be designated.

The live-steam supply must be arranged as shown on plan, viz:

A 6-inch iron body, brass-mounted gate valve must be attached to a nozzle of main steam pipe above boilers at A. A 6-inch pipe, A,

B, C, D, will lead at a suitable height of about 18 feet above the floor line of the shop to a point D, and there branch into two 4-inch pipes, each provided with a 4-inch brass stop valve at this point. One line of 4-inch pipe must then run to a point E, where it is to branch into two pipes, provided with a 4-inch brass stop valve at F and with a 3-inch brass stop valve at G. One line of pipes will then run from G to a point H on west wall, and from H to K, reducing on its way as follows: G to I will be of 2½-inch pipe, and I to K of 2-inch pipe.

Another line of pipes will run from F to L, and then along west face of brick piers to a point P, reducing on its way as follows: E to M will be of 3½-inch pipe, M to N of 3-inch pipe, N to O of 2½-inch pipe, and O to P of 2-inch pipe. The second 4-inch branch at D will descend near the wall to a point below the floor, then turn at right angles to a point R, and then run to a point S in the passage for the underground driving shaft. At S it will turn at right angles to a point T at the brick pier, and run up on said pier to a height of about 16 feet above the floor line, whence it will run at that height along the west face of brick piers to a point X. This pipe line will reduce as follows: from D to T it will be of 4-inch pipe, from T to U of 3½-inch pipe, from U to V of 3-inch pipe, from V to W of 2½-inch pipe, and from W to X of 2-inch pipe.

Brass stop valves of required sizes must be interposed at points I, N, and V.

At the lowest point of underground pipe at S a suitable steam trap with 1¼-inch outlet must be provided in order to allow the escape of air and water of condensation without the loss of steam. The outlet of trap must be connected with main return pipe where it passes through the ditch for underground shaft.

The three lines of main supply pipes must be hung to the iron girders (the two lines in west aisle at a height of about 18 feet above the floor line and the line on east side at a height of about 16 feet) by means of heavy and suitable expansion hangers.

Proper arrangements (miters) must be made at two suitable points in each one of the three main supply pipes to compensate for changes due to expansion and contraction. The 6-inch main supply pipe from boilers to point D, and the 4-inch pipes from D to E and from D to T, must be covered with suitable heat-retaining covering.

The fitting at C will be a T, from the northern branch of which a 6-inch pipe will run to the exhaust pipe of the steam engine, below the floor of the engine room, to be there connected to same. At a suitable point of this pipe above the floor a 6-inch gate valve will be interposed and the pipe will be provided with suitable covering.

The branch supplies leading to coils must be situated as shown on plans, and hung from iron girders, about 19 feet above the floor line, but must in no case project below the under line of such girders. A T for a 2-inch supply pipe for coils marked a_1 must be inserted at a suitable point between D and E, but connections from said T to heating coils will be made by the Ordnance Department.

Another 2-inch connection must be provided also at the northern trunnions of the main supply pipe on east side, for the supply of a coil marked b_1, but connections to said coils will be made by the Ordnance Department.

Steam supply pipes to coils *d* will be below floor from piers to coils. These coils *d* are fed alternately from the east and west sides, as shown, and their returns are arranged on same side of shop as supplies. It will be seen that the returns are arranged in two groups, on east and

west side. They will be arranged as indicated on plan, and no changes must be made from this without special permission.

There will be three lines of main return pipes arranged as shown on plan, running in a southerly direction and connecting separately with drip tank Y.

No pipes whatever must cross or obstruct the floor at any point; thus returns above the floor can be had only along side of wall, where doors or other passages will not be obstructed. All return pipes to be of a size adequate to the amount of condensed water to be carried by them. The main runs should gradually increase in diameter, and their terminals at drip tank Y must be not less than $2\frac{1}{2}$ inches diameter. This drip tank Y must be made of good quality cast-iron, $1\frac{1}{2}$-inch metal, 30 inches in diameter and 24 inches deep. It must be made in two pieces, a tank and a cover for same. Both parts must be bolted together steam tight. The tank must be provided with all necessary accessories for the reception of the returns, and with means for connecting the 3-inch drain pipe all near its upper edge and a 2-inch blow-off at bottom, provided with a 2-inch valve. All returns or drips must be provided with stop valves before joining the tank.

The 3-inch main drain pipe must lead down into the drip tank, from the connection near the top to a point $2\frac{1}{2}$ inches above the bottom. From the drip tank it will run in a northerly direction to a point Z in passage of underground shaft. From Y to Z the pipe must have a uniform fall of 2 feet; it must be properly supported in a ditch prepared for this purpose by the Ordnance Department. From Z to D the 3-inch main drain pipe will run parallel and close to the 4-inch supply pipe, and thence parallel to the 6-inch main supply pipe to a point Z_1, near rear end of steam boilers. But the elevation of the main return pipe above the floor line will not be greater than required by the location of the automatic return traps and for their successful operation. In its course above the floor it must be well secured to the building, similar as the supply pipe.

The total height available for the three return pipes from steam coils to drip tank Y, below the floor of the shop, is 15 inches, and they must be properly graded from end to end.

The drip pipes from coils marked a_1 and b_1 will lead to the nearest points below the floor of the return pipes on west side and east side respectively, and the contractor will arrange suitable fittings for such connections, while the connections proper will be made, and material for same will be provided by the Ordnance Department. The three returns from coils to drip tank Y, as well as the main drain pipe from Y to Z, must be provided at at least two points each with miters or other suitable means to allow for expansion.

There must be also furnished and properly erected at rear end of the three steam boilers in boiler house three Albany steam traps, No. 1 or equal, whose proper working must be guaranteed by the contractor. They must be suitably located, one over each boiler, and all necessary connections from main return pipe at Z to steam traps, and from steam pipe of boilers to steam traps, with all necessary valves and other fixtures, must be made. The discharge pipes from steam traps will lead down to a point below the flues of boilers, to be connected there to a 3-inch pipe, running horizontally along rear wall of boilers. From this pipe three 2-inch connections will be made with three 2-inch valves, already provided for on top of the blow-off pipes of the three boilers.

The general arrangement of steam boilers and steam traps, etc., is shown in blue print of boiler house.

The main drain pipe must be provided near point Z with a two-inch stop-valve, and a two-inch connection must be made from this to an 8-inch vitrified drain-pipe, located at bottom of passage for underground shaft, in order to empty the main drip-pipe, when required.

All parts of the heating system must be properly dripped.

All pipes must be standard wrought-iron steam-pipe; all sizes above 1¼-inch to be lap welded. All fittings to be of cast-iron. All valves to be of approved quality and kind. All valves below two inches must be Fairbanks, Jenkins, or Scott disk valves. All materials to be used must be of the best quality.

Bidders will furnish a description of all materials their bid is based on.

All cutting in walls and floors for the passage of pipes will be done by the Ordnance Department, but no other labor or any material whatever will be furnished to the contractor.

The entire heating system is to be furnished complete with steam on.

The contractor is required, in order to avoid any misconstructions as to sizes and dimensions, to take all measurements for his work in the building, as he solely will be responsible for the proper execution of the plant. Bidders will state time at which the entire work will be completed by them. If any delay occurs in the completion of the plant, in perfect running order, beyond the date specified, a reduction shall be made in the price of said plant of $10 per day for each and every day (excepting Sundays) after said date until the completion of the plant. Payments will be made in two installments, one of 85 per cent on the completion of the whole work, steam on, and one of 15 per cent. after a successful trial of four weeks. The contractor to repair all defects until the time of the last payment, resulting from defective material or workmanship, at his own expense.

The boilers carry a pressure of 100 pounds per square inch, and the whole heating system must be capable of standing this pressure.

A separate bid will be received, subject to all stipulations and all requirements in regard to material and workmanship, as stated in the foregoing specifications, for the following work.

The 3-inch main return pipe of the steam-heating plant of the north wing will be disconnected at a point A_1 in the passage for underground driving shaft, and a three-inch pipe will be run alongside the 4-inch supply pipe and parallel to it to B, thence to C_1, where it will lead up on the brick pier to a height suitable for the steam traps, then run to D_1, E_1, and F_1, parallel with the 6-inch main supply pipe. Three Albany steam traps No. 1 or equal, whose proper working must be guaranteed by the contractor, must be furnished and properly erected on top of existing steam boilers in boiler house. They must be located, as shown in blue print of boiler house, one over each boiler, and all necessary connections from 3-inch return pipe at F_1 to steam traps, and from live-steam pipe of boilers to steam traps, with all necessary valves and other fixtures, must be made. The discharge pipes from steam traps will run down to a point below flues of boilers, to be connected there to a 3-inch pipe, running horizontally along rear wall of boilers. From this pipe three two-inch connections will be made with three two-inch stop valves on top of blow-off pipes of the boilers, which valves will be furnished and put in position by the Department.

The general arrangement of steam boilers and steam traps, etc., is shown in blue print of boiler house.

The existing 6-inch main supply pipe from boilers to D_1, and the existing 4-inch supply pipe from D_1 to where it emanates above the floor again near A_1, must be covered with suitable heat-retaining covering.

APPENDIX 25.

REPORT OF PRINCIPAL OPERATIONS DURING THE YEAR ENDING JUNE 30, 1892.

ROCK ISLAND ARSENAL, ILLINOIS,
June 30, 1892.

SIR: I have the honor to submit the following report of principal operations at Rock Island Arsenal, Illinois, under my charge during fiscal year 1891–'92:

I. ROCK ISLAND ARSENAL VIADUCT.

About the beginning of this fiscal year proposals were called for by the commanding officer Rock Island Arsenal for furnishing, constructing, and erecting the iron work alone, or the iron, wood, and other work complete (except masonry, excavations, and fills), for a viaduct from the south end of the Rock Island wagon bridge, between Rock Island and the city of Rock Island, over the railroad tracks which adjoin the approach to the said bridge, including the raising of this bridge to an inclination required to form a continuous roadway with the viaduct, in accordance with an act of Congress approved August 30, 1890, appropriating $35,000 therefor.

On July 25, 1891, the bids of ten bridge companies, varying from $10,640 to $23,900 for iron work alone, were opened.

The competition being one of plans as well as prices, the contract was awarded, after due consideration, to the Phœnix Company, of Philadelphia, for $16,024, work to be completed by December 10, 1891.

Owing to extensive experience and facilities for stone work at this arsenal it was decided that the United States build all masonry, retaining walls, and foundations for spans, pedestals, and posts, including excavating, filling, and the placing upon the present piers of the wagon bridge stone bases 16 inches thick, to receive the iron pedestals supporting the Rock Island wagon bridge when raised.

By a comparison of the bids for wood work with cost of such work at this arsenal, it was found that cheaper and better work could be done here.

A preliminary survey, made with the assistance of Mr. W. Otto Grohnen, mechanical engineer, showed that no landmarks exist for the old plats of the Government land in Rock Island city at the south end of the Rock Island wagon bridge.

Accompanied by Maj. William McConochie and City Engineer H. D. Paddock, the center line of Twenty-fourth street, on which part of the viaduct is placed, was accurately run from landmarks and the new improved streets some distance south. It was then found that the center lines of the Rock Island wagon bridge and Twenty-fourth street, making an angle of 30° 18′, intersected so near the south railroad track

(Chicago, Burlington and Quincy Railroad) that the foundations of the south piers for the 100-feet through span would interfere with the running of trains. Accordingly the center line of this part of the viaduct was fixed with its south end in the middle of Twenty-fourth street, and on the inner north sidewalk line of Third avenue, and its north point thrown 1½ feet west of the first-mentioned point of intersection, thus giving pedestals for south piers of 100 feet through span the required 4 feet clearance from the railroad track, all of which is shown graphically on maps on file in the drawing room.

The strip of land conveyed by the city of Rock Island to the United States for viaduct site being 50 feet in width and the viaduct generally 38 feet wide, it will be seen that a strip from about 4½ to 7½ feet surrounds the viaduct.

Great care was taken to locate the flared entrance, guard-house and stairs so as to clearly put all parts of the viaduct on United States land and not to encroach upon the city, railroad, or property rights of adjacent owners.

These facts are recorded in view of the absence of landmarks in the immediate vicinity and any trouble that may arise on these points in the future.

Masonry.—About the middle of August ground was broken for the masonry construction forming the south approach and piers in the city of Rock Island. This approach consists of an earth and stone fill 125 feet long, 38⅔ feet wide, with retaining walls 7 feet thick at bottom and tapering to 3 feet at top, resting 8 feet below the surface on a Dyckerhoff cement bed 1 foot thick, as no rock foundation was found calculated to bear with safety the required loads mentioned further on.

The piers were similarly constructed. Anamosa (Jones County, Iowa) limestone, rubble below surface and ashler above, with breast-high wall 18 inches thick, topped with coping 2 feet wide, was used.

The entrance on Third avenue is flared and surmounted with handsome electric-light posts, and the coat of arms of the Ordnance Department is attached to parapet wall beneath coping.

The roadway is paved with granite and has a grade of 1 in 24.

The stone work was done under the supervision of Robert McFarlane, for many years the efficient master mason, and is in keeping with similar work at this arsenal.

Finished September 30, 1891; cost, masonry complete, $12,500.

Iron work.—For some reason unknown there was considerable delay in the arrival of the iron from the Phœnix Mills, so that work was not commenced until December 7.

On December 10 the contract was extended until January 31, 1892.

The erection work from the masonry approach to the south end of the wagon bridge was pushed forward rapidly.

Mr. F. E. Robbins, a skilled mechanic, inspected every field and most of the shop rivets in all the work, and closely watched every detail of construction. The company's workmen then proceeded to raise the bridge, the north end of which remained fixed as a pivot line, while the south end was raised to a height of about 12 feet. This work began by lifting all the end posts of the bridge (except the last two at the north end) in order to place under the base castings the lifting plates for the hydraulic jacks. In putting in the lifting plates at the middle of the bridge, west side, both castings, upon which the batter posts rest, were broken, but not enough to endanger the safety of their spans. These castings contain the lower chord pin and rocker to allow for expansion. Both cast iron solid shoes, east and west trusses, in first pier from north end bridge were cracked.

All these lifting plates were in position December 24, when the work of lifting the bridge by hydraulic jacks and blocking up was begun at the north end of the bridge, and continued from span to span, southward, gradually with lifts from a few to 18 inches, thus giving the bridge the required inclination.

This part of the work progressed slowly, as the Phœnix Bridge Company had provided neither sufficient hydraulic tonnage nor strong enough lifting apparatus.

On the afternoon of December 28, while lifting on the first pier from the south end, the lifting plate and connecting pin broke, throwing a piece off the wall plate, which struck one of the Phœnix workmen, who was driving a wedge between blocking and bottom casting of end posts, and knocked him off the pier, killing him in a few minutes. This accident, in connection with the intensely cold weather, caused some delay, but the iron pedestals were finally placed in position under the inclined bridge January 22, 1892. The carpenter work, under Master Carpenter John Channon, was pushed along expeditiously, so that the viaduct was opened for public traffic January 23, 1892. The rocker pin, on the west truss at the south end of the wagon bridge, is out of center from the supporting Phœnix column 1½ inches toward the north, and the corresponding rocker in the east truss end is out of center three-fourths inch, both at 34°. This defect was very likely caused by the spans slipping northward slightly while being raised.

With a maximum loading of 72,000 pounds on each column, there is only a bending moment of 108,000-inch pounds. This would cause a stress on the extreme fibers of only 5,530 pounds, which, of course, is too small to make any trouble. This column is also supported by being connected with the adjacent plate girder, so that it is stronger than is called for by the maximum load of 72,000 pounds. The broken castings have been since reënforced by ⅝-inch plates, fastened by tapped bolts, so that the raised bridge is as safe as any similar structure containing so much cast iron. Raising the bridge to the required inclination, 1 in 53, changes the stresses less than would appear at first, as the angle is small. A strain sheet for the raised bridge is on file in the drawing room.

General description of finished structure.—The viaduct proper consists of a 100-foot through span reached from the island by the Rock Island wagon bridge raised to an inclination of 1 in 53, followed by two 45-foot plate girder deck spans at the same inclination. The south, or stone approach, is followed by four 45-foot plate girder deck spans, the whole at an inclination of 1 in 24 to the 100-foot through span. The new structure has a roadway for vehicles with double track for street cars, flanked by sidewalks for foot passengers, in conformity to the old wagon bridge. A double railing of 2-inch pipe separates the foot from driveway. Overhanging electric light posts are conveniently placed. The street railroad company furnished the rails and track material. A new guard house and iron stairs affording access to the viaduct for foot passengers coming up Second avenue have been provided. The wagon bridge was repainted to conform to the color of the new structure. Telegraph and telephone wires are crossed in cables on neat fixtures on top struts of the bridge, while the electric light wires were placed on posts on the downstream side of the bridge piers, below the sidewalk and out of reach. All iron used for viaduct was inspected and passed by Capt. D. A. Lyle, Ordnance Department, with following results:

Elastic limit, 27,400 pounds per square inch to 34,600 pounds. Tensile strength, 45,000 pounds per square inch to 53,320 pounds. The via-

duct will sustain a live load of 100 pounds per square foot, and a concentrated load of two passing electric street cars, weighing, when fully loaded, 12 tons each, thus fulfilling the requirements of a first-class structure, capable of sustaining the heavy loads of war material in case of necessity. To the public using the bridges of the island between the adjacent cities the viaduct affords a safe and expeditious means of crossing when compared to the former dangers and delays at the old railroad crossing.

II. ROCK ISLAND BRIDGE.

The following work was done at the bridge:

New upright flue steam boiler, steel, 60,000 pounds per square inch tensile strength, test 150 pounds cold water, together with new steam pipes, valves, injectors, and water gauge; new cast-iron boiler plate, ash chute; new engine shaft and connecting rods for same; new hydraulic valves; engine cleaned, painted, and varnished; new eccentric shafts, worm gears, and chain for ends of draw span; three new traverse wheels for turntable; hydraulic rams and pump plungers re-turned and polished; iron railing on sidewalk of bridge extensively repaired; new iron gate at Davenport end, and new guard rail fence just north of island end as protection against runaway teams; new iron hand railing on each side of draw pier; new timber rests on draw pier for draw to rest on when open; new coal bunkers, capacity 16 tons, on draw span; new plank platform between engine and boiler room; 16,000 feet oak plank for roadway; two new fire tanks of 40 barrels capacity placed near island shore span; new locking apparatus at ends of railroad deck of draw. Most of this work was done at carpenter and machine shops or by the bridge engineers and firemen while draw was closed for navigation.

The Western Union Telegraph Company replaced the two weak towers, on spans adjacent to ends of draw with stronger towers placed equidistant from the central or draw tower, thus equalizing the sag at the end of the draw. On very warm days the top chord of draw, which is exposed, becomes more heated and extended than the lower chord, which is covered, thus causing ends of draw to sag about $2\frac{1}{2}$ inches below proper position, and making the lifting up of the draw ends, so as to make the rail and wagon ways continuous with the rest of bridge, a difficult operation.

Metal shims and other remedies have been applied during the year without success.

No serious accidents or difficulties have occurred during the year, due to the watchfulness of the guards.

Owing to the extension of the Government jurisdiction into the city of Rock Island, it was found necessary to have the viaduct guards sworn in as special city policemen, so that the entrance to the viaduct can be kept clear of disorderly persons.

The police patrol box, established near the guards at the Davenport end of Rock Island bridge, has been a convenience to them in disposing of offenders. I would recommend that the guards be required to wear, when on duty, a simple and inexpensive uniform of dark blue.

The new boom was placed in position early in the season, but the anchor chains were broken by a heavy tow, during the late flood. Height of water 19.40 feet, being .08 feet higher than any previous record.

Abstract of travel over bridge during the year:

	Passing north.	Passing south.
Engines with trains	9,204	9,138
Engines without trains	614	676
Total engines	9,818	9,814
Passenger cars	15,390	15,507
Freight cars	131,541	129,695
Foot passengers	250,498	252,812
Teams	193,190	191,384
Steamboats	1,183	1,191
Barges	265	238
Rafts	.....	618

A double iron rail fence (2-inch piping), with strong posts, has been placed on both sides of the causeway. Fort Armstrong avenue has been given a general repair. New and large poles have been put in by the telegraph, electric light, and power companies.

The Western Union poles on the east side of the avenue were placed some 6 feet nearer the railroad tracks, and the avenue widened some 12 feet, with a dry retaining wall to hold up railroad embankment and macadamize. The poles on the west side of the avenue were placed west some 3 feet, allowing a needed widening of the single narrow sidewalk on the avenue to that extent. A number of wires have been cabled. The People's Light and Fuel Manufacturing Company has placed a cut-off box near island end of the Rock Island bridge under charge of our guard, which, in connection with a similar box of the Electric Power Company at same point, allows the current to be cut off in case the bridge gets charged or other electrical accident.

III. ROCK ISLAND ARSENAL RAILROAD.

The track in the vicinity of storehouse A has been regraded, ballasted with cinders, and hewn oak ties laid where necessary. The track from West avenue to the junction with the Chicago, Rock Island and Pacific Railroad has been weeded and repaired.

In this connection it may be mentioned that the Chicago, Rock Island and Pacific Railroad Company has constructed a double-track plate-girder span over Rock Island avenue, widened the embankment, and laid a double track between the Rock Island bridge and its bridge over the slough, with switches at these points. The arsenal track is now connected with the west Rock Island Railroad track. The slopes of these embankments have been neatly covered with grass and white clover.

IV. CARE AND PRESERVATION.

Owing to the limited means and appropriations but little progress has been made in this direction. Macadamizing the south half of the main avenue was continued to the flagstaff, making an excellent drive for light traffic from that point to the main gate.

A rolled cinder sidewalk has replaced the former gravel one on the south side of the avenue. The other roads have been kept in repair. The open drains and outlets around the island were cleared and cleaned in early spring, which aided much in carrying off the water of the incessant rains. The floor and piers at the canal bridge were repaired and

cleaned at various times. The street drainage on the far side was found to be directed against the pier, undermining it. The bridge is subjected to heavy and increasing stresses, due to the establishment of a rock-breaking mill on Sylvan Island and the passage of the heavy machinery and loads pertaining thereto. By the provisions of the agreement between the United States and Moline Water Power Company, April 8, 1869, the United States is bound to maintain this bridge, and it is recommended that a small annual appropriation, say $250, be granted for this purpose.

During last summer and fall the weeds and grass growing in the streets and area of shops were removed, but the continuous wet season and flood have prevented much work of this character this spring.

Sidewalks of hammered top flagging, much smoother for walking on than the split stone, have been laid around shop K, the grounds partially graded, trees planted, the road in front of shop macadamized, and the stone on north side of Main avenue and on Fourth street broken up to this road, with gutters and sewer connections complete.

The leaks and cracks in the main stone reservoir were repaired. Some pointing up and painting around shops were done.

As to the buildings, it can hardly be said that they are being preserved. Mortar is falling out of the gutters, so that one can see through the cracks in some instances, while the painting is almost entirely off in some cases, like the iron roof of the rolling mill (shop F). It is estimated that $15,000 of painting alone is necessary. The detachment has worked faithfully, but it is too small for the necessary police work. One hundred men could be maintained comparatively more economically than the present force of 60 men, and it is therefore recommended that the detachment be increased to that number.

In regard to fire protection, 600 feet of cotton hose have been purchased, all fire ladders and buckets repaired, the hot-water apparatus put in order and hot water kept in fire engine at all hours, fire department lanterns provided, the stable for fire team enlarged, and a reassignment made of the fire duties of the detachment. The two hose reels are rickety and should be replaced by a substantial modern hose wagon. As there is a large surplus of horse power at the dam, it is recommended that a system of electrical lighting for exterior illumination be substituted for the present gasoline lamps. The bridges and roads could be lighted economically by the same plant. The guards generally have well performed their duties, many times under trying circumstances.

V. SHOP K.

During this spring the following work has been done at this building:

Sandstone steps and platforms, with limestone foundations, erected on the front and east sides; the basement covered with broken stone, leveled to receive the usual concrete floor. With the balance on hand ($4,240.30) and the amount required in the annual estimate ($7,800) this shop can be finished.

VI. STOREHOUSE K.

Since June 30 last the principal work on this building has been as follows:

Doors, window frames and sashes, with locks and fastenings, put in and painted; wooden ceiling put up and oiled; floors laid; iron stairs

erected; retaining wall, with coping, sandstone steps and platforms on south and east sides completed; concrete basement and the ramps on east side laid. This storehouse will bear a maximum load of 400 pounds per square foot on each of the three floors. Balance on hand, $200.38; required to finish as per annual estimate, $8,750.

VII. INSPECTION AND SHIPMENT OF STORES.

I am charged with the inspection of all material for shops and all ordnance and ordnance stores received and shipped.

Total number of orders for supplies for Army and militia inspected, 1,286, aggregating 1,043,934 pounds; stores received on 459 invoices amounted to 971,528 pounds; issues to sundry persons, 136; the whole amount being about 2 per cent of the average yearly shipments by rail by the Quartermaster's Department.

JNO. T. THOMPSON,
First Lieut., Ord. Dept., U. S. Army.

The COMMANDING OFFICER ROCK ISLAND ARSENAL.

ROCK ISLAND ARSENAL, *August 5, 1892.*

Respectfully forwarded to the Chief of Ordnance, U. S. Army.

This report, together with report of Capt. M. W. Lyon, of work under his charge, forwarded by indorsement of June 20, 1892, to which attention is invited, makes the report of principal operations at this arsenal for the fiscal year ending June 30, 1892.

A. R. BUFFINGTON,
Colonel, Ord. Dept., Commanding.

(3996–'92.)

APPENDIX 26.

REPORT ON DEVELOPMENT OF WATER POWER AT ROCK ISLAND, ILL.

(20 plates.)

ROCK ISLAND ARSENAL,
Rock Island, Ill., June 9, 1892.

SIR: I have the honor to make the following report of the work done in the further development of the water-power pool at this arsenal, in accordance with the act passed by the Fifty-first Congress, at its first session, appropriating $101,000 therefor. As shown on the accompanying map (Pl. I), a channel in former years had been cut to a depth of 4 feet below the zero of the river, 150 feet wide, from the head of the wing dam to the head of the island, and to a width of 125 feet from that point to the Moline bridge. This appropriation was designed to clean out the deposits left in this channel and to increase its width, making it 200 feet wide from the commencement of the wing dam to the Moline bridge. After taking soundings and ordering material the work of the construction of the coffer dam was actively commenced July 6, 1891, the water in the river being at a 3.20-foot stage at that date. This coffer (as shown in Pl. I) was 2,967 feet long; from E to F it was 12 and from F to G 10 feet wide; details of the construction of this coffer are shown in Pl. II.

Although the first cost of a wide coffer is much greater than a narrow one, still it was thought best, from past experience in work of a similar kind in this locality, to make it sufficiently strong to resist any ordinary freshet that might arise. The work of erecting this coffer and filling the same with mud progressed favorably from week to week, the water in the river gradually falling as the work progressed till it finally became so low that it greatly increased the cost of the filling, as the boats used with the dredge often grounded before reaching their destination, and some of the mud we were compelled to obtain from the shore by the aid of wheelbarrows. As it was necessary to have some water constantly flowing through the wash gate in the Moline dam wall, in order to clean out the sewerage of the city of Moline that accumulates there, a 16-inch pipe with gate was inserted in the coffer near the Moline shore for this purpose. At first it was designed to use a siphon in place of the pipe, since it would be in every way safer for the coffer, but the water fell so that it was seen that a portion of the mouth of the siphon would be above the surface of the water, and therefore this idea had to be abandoned.

The coffer dam was finally completed August 26, when the water had fallen to a .65 foot stage; then by opening all the gates in the dam wall the water was gradually drawn from the pool. It took three days to get the bottom dry enough so the men could commence to work

there, making ditches for drainage, while the teams were not able to enter the bed of the pool to do any work until a week later.

As it was desirable to complete the work as soon as possible, before there should be any serious rise in the river, it was thought best to supplement our hand drills with some kind of power drills, and therefore, on August 22, 1891, there was sent to all interested parties the following advertisement:

PROPOSALS FOR DRILLING ROCK.

ROCK ISLAND ARSENAL, *August 22, 1891.*

Sealed proposals, in triplicate, will be received at this arsenal until 1 o'clock p. m. on Tuesday, September 1, 1891, for drilling by power about 10,000 holes, more or less, in the rock bottom of the water-power pool at the head of Rock Island.

The average depth of holes to be 3 feet, and they must be of sufficient diameter to accommodate dynamite cartridges $1\frac{1}{4}$ inches in diameter.

Bidders must state the power they propose to use, whether steam or electricity, and must state the number of linear feet they can drill per day.

The United States has a steam pump stationed in the water-power pool, and when this pump is not in use pumping out the pool it will furnish to the contractor steam power with which to operate his drills or dynamos, to the extent of 20-horse power.

The contractor must assume all risks from floods caused by the rising of the river or breaking of the coffer dam, and all casualties of every description, and must furnish all labor and material of every kind incidental to or in any way connected with the operation of the drills used by him, except the steam power to the extent of 20-horse power furnished by the steam pump above referred to when it is not in use doing its legitimate work of pumping out the pool, and four men to move machines.

A public exigency requires the continuance of active work in the water-power pool for more than eight hours per day, and bidders will therefore state the number of hours per day during which they can keep the drills at work.

If the work should continue after dark, the contractor to furnish the necessary artificial light.

In order that the bid may be easily compared, bidders should state the price per linear foot for drilling the holes.

The United States reserves the right to reject any or all bids or parts thereof.

Envelopes containing bids should be sealed, marked "proposals for drilling rock," and addressed to the undersigned.

Bidders are invited to be present at the opening.

M. W. LYON,
Captain of Ordnance, Commanding.

In reply to this advertisement bids were received varying in price from 35 to 12 cents per linear foot, the former bid being for drilling the rock by steam power and the latter for drilling by electricity. The contract for this work was awarded to F. B. Badt, the western manager of the Thomson-Van Depoele Electric Mining Company, for 12 cents per linear foot. As their drills had to be shipped from Boston, and the railroads were blocked with freight, it was not till October 23 that they could commence active operations. In the mean time, as work was commenced near the coffer, hand labor was employed for our drilling at that point, most of which was in a sand rock known as carboniferous conglomerate or a millstone grit. A careful measurement of this drilling was made each day and the cost carefully separated from all the other expenses, and as a result I find we drilled by hand 35,151 feet for $4,909.18, making the cost average nearly $13\frac{5}{7}$ cents per foot.

In some experimental drilling by hand in the limestone I found the average cost for that rock (which was the kind drilled by the Thomson-Van Depoele Mining Company for 12 cents per foot) was $20\frac{6}{10}$ cents per foot.

The steel used for the hand drills was what is known as the black-diamond octagonal, the sizes being $\frac{7}{8}$, 1, and $1\frac{1}{8}$ inches, making drills $1\frac{5}{8}$, $1\frac{3}{4}$, and $1\frac{7}{8}$ inches, and these were found to give better results than

the larger-sized drills used in previous years, as it diminished the amount of the cutting surface.

The electric plant furnished by F. B. Badt for the fulfillment of his contract consisted of ten drills. Six of these were mounted on tripods and four on carriages running on section track, such as we used for some of our work in the pool. These drills are shown in Pls. VII, VIII, IX, X, XI, and XII. They gave good service, but for work of this character, owing to the ease with which the drills mounted on carriages could be moved from place to place, they were preferred to those on the tripods. When worked up to its capacity, the electrical plant was capable of drilling over 10,000 feet per month, but the steam power we were able to furnish them was not always equal to their capacity. The generator they used also supplied the pumping station with electric light and furnished power to explode our blasts at the point where the drills were working. This drill plant was under the direct charge of Mr. A. S. Garfield, who came from Boston for this purpose, and much of its success is due to his perseverance and skill.

As stated previously, the greater portion of the rock drilled by this company was hard Hamilton limestone, filled with seams, fissures, and cavities containing fire clay, sand, and pebbles. This made the drilling much more difficult than if the rock had been homogeneous.

The sand pumps were first made of tin, with a leather valve in the bottom, but an experimental lot made of galvanized iron, with a bullet or marble for a valve, gave equally as good results, and as their endurance was much greater than the tin ones, and their cost but little more, they were preferred for this work.

Except in a few instances, when it was impossible to do otherwise, our blasts always took place at noon and after the men had quit work in the evenings. It was by observing these precautions that no accident of any kind took place while we were engaged in this work, though many thousand pounds of dynamite were used. All the charges were exploded by the Laflin & Rand hand battery, except in the limestone rock; here advantage was taken of the current furnished for the electric drills, and often 75 and 100 holes were fired simultaneously, as shown in Pls. XIII and XIV. All of our blasting material was dynamite, containing 40 per cent nitrogylcerine. When it became cold, so we had to thaw it out, we first used the sand bath, but after an accident occurred that came nearly proving serious from the dynamite taking fire in the sand and burning, and then exploding, demolishing our dynamite house, the hot-water method of thawing was adopted, and it worked exceedingly well, and seemed absolutely safe, care being taken to let none of the dynamite touch any metal.

To take care of the seepage, rainfall, and spring water that abounds in the bed of the pool, two pumps were placed there, one at the point where the coffer intersected the wing dam and the other just above the Moline bridge, shown at H, on Pl. I, the water by this means being pumped into ditches leading to the wash gate in the Moline dam wall.

The pumping station near the Moline bridge (H, Pl. I) also furnished the steam power for generating the electricity used with the electric drills. This power house is shown in perspective in Pl. XII.

In addition to using wagons, cars also were employed to help haul away the rock and the mud excavated. For this purpose a double-track railroad, 28-inch gauge, was laid the entire length of the pool; each car was furnished with a dump-box capable of holding 1 yard of material, these boxes being arranged so that when it was desired to unload them they could readily be tilted. The cars and track are shown in Pls. XV, XVI, XVII, XVIII, and XIX.

The track was so made that it could be easily shifted so as to keep the cars as close to the excavations as possible. Teams were employed to haul these cars to the inclines at head of the island and wing dam, two horses hauling from 6 to 8 loaded cars. At the wing dam and the head of the island, where we had our principal dumps, stationary engines were employed to haul the cars up the steep grade, and after reaching the summit horse power was again applied to move them wherever desired. This arrangement is shown in Pl. XX. After the cars had been relieved of their loads, they were at once returned, running down the incline by gravity with sufficient force to nearly carry them to the point where they would be used again.

On an average 80 cars were engaged in this work, and their employment proved very satisfactory and enabled a large quantity of material to be removed in a very short space of time. Each car made on an average over ten trips per day, and work was pushed continuously from one end of the line to the other. It would have been better if we could have had more cars for the work, for there were times, when some of them were being repaired, that the lack of cars curtailed our excavations.

The water kept below a 1-foot stage nearly the entire time the work was progressing, and one week it went below the former zero of the river; this enabled us to work to a great advantage and to finish the work asked for by the act of Congress at a very early date and at a cost but little over one-half the sum appropriated. Advantage was taken of this fact to widen the channel still more than called for in the act of Congress. As shown in Pls. I and III, our excavations were over twice the quantity first estimated for, Pl. III being a table showing the weekly and total excavations, the excavations called for by the estimates being 24,391 cubic yards of mud and 29,466 cubic yards of rock, while the amounts actually excavated were 54,167 cubic yards of mud and 60,746 cubic yards of rock.

The work of excavating suddenly stopped on January 16, 1892, owing to our coffer breaking and flooding the pool. For a week previous to the flooding the ice had gorged and suddenly raised the water so that it commenced to flow over the top of our coffer and to leak through the Benham's dam wall. A successful fight was made in keeping the pool dry from this sudden rise till on the date above mentioned a portion of the dam, about 80 feet in length, gave away, when work, of course, had to cease. This portion of the dam that gave away had been more or less infested with muskrats, and the coffer guards, of whom we had three at night and two in the day, had destroyed during the season twenty-five or thirty of them at this point, and it is presumed that it was the work of these animals that caused the break. We were very successful in getting out all of the cars and engines and nearly all of the track and tools before we had to abandon the place, and these all have been carefully repaired and stored away for any work in the future of a similar character.

Advantage was taken of the situation when the pool was dry to accurately survey and sound the bed, so future operations there could be based upon the exact status of affairs, without the cost of taking soundings when water is in the pool. These surveys are shown on the map (Pl. I) and also in a tabulated form in Pl. IV. The wing dam was also repaired and brought up to the grade established several years before on Benham's Island. At the upper end of this dam a high nose was erected to serve as a protection against floating ice and as a landmark for pilots when the other parts might be covered with water; these are all shown in detail in Pl. V.

Four cross sections of the pool, on the lines A, B, C, and D, on Pl. I, were accurately made, the results of which are tabulated in Pl. VI. By the aid of these an exact calculation can be made of the amount of water entering the pool at any time. The bed of the pool in front of Benham's dam was also carefully surveyed while the work was going on, the results of which are shown in Pl. I. By the use of this, should any work in the future be contemplated there, a careful estimate can be made without the expense of making soundings.

In addition to showing the amount of the excavations, Pl. III also shows where this material was placed.

It will be observed that some was hauled to a small sand bar that had formed in the pool; shown in Pl. I.

As this bar was liable to wash away and fill our excavated channel it was thought best to so hold it down with some of our excavated rock that this could not ever occur.

The entire coffer dam has been removed and the mud filling carefully dredged out so that the pool is now receiving the full benefits of the excavated channel, and a full supply of water furnished to all the wheels.

For assistants in this work I had J. H. Southwell as engineer and superintendent, W. A. P. Totten as foreman, and Andrew Christensen, George Christensen, Andrew Pedersen, John Isaacson, and Curtis B. Knox as assistant foremen.

All except J. H. Southwell had been educated for this work by being employed by former commanding officers in similar operations in this pool work in previous years.

Too much praise can not be awarded each one individually, as much of the success of the work was due to their untiring energy and faithfulness.

Respectfully, your obedient servant,

M. W. LYON,
Captain of Ordnance, U. S. Army.

Col. A. R. BUFFINGTON,
Commanding Rock Island Arsenal.

(353A–'92.)

MAP

Of Development Work in WATER POWER POOL,

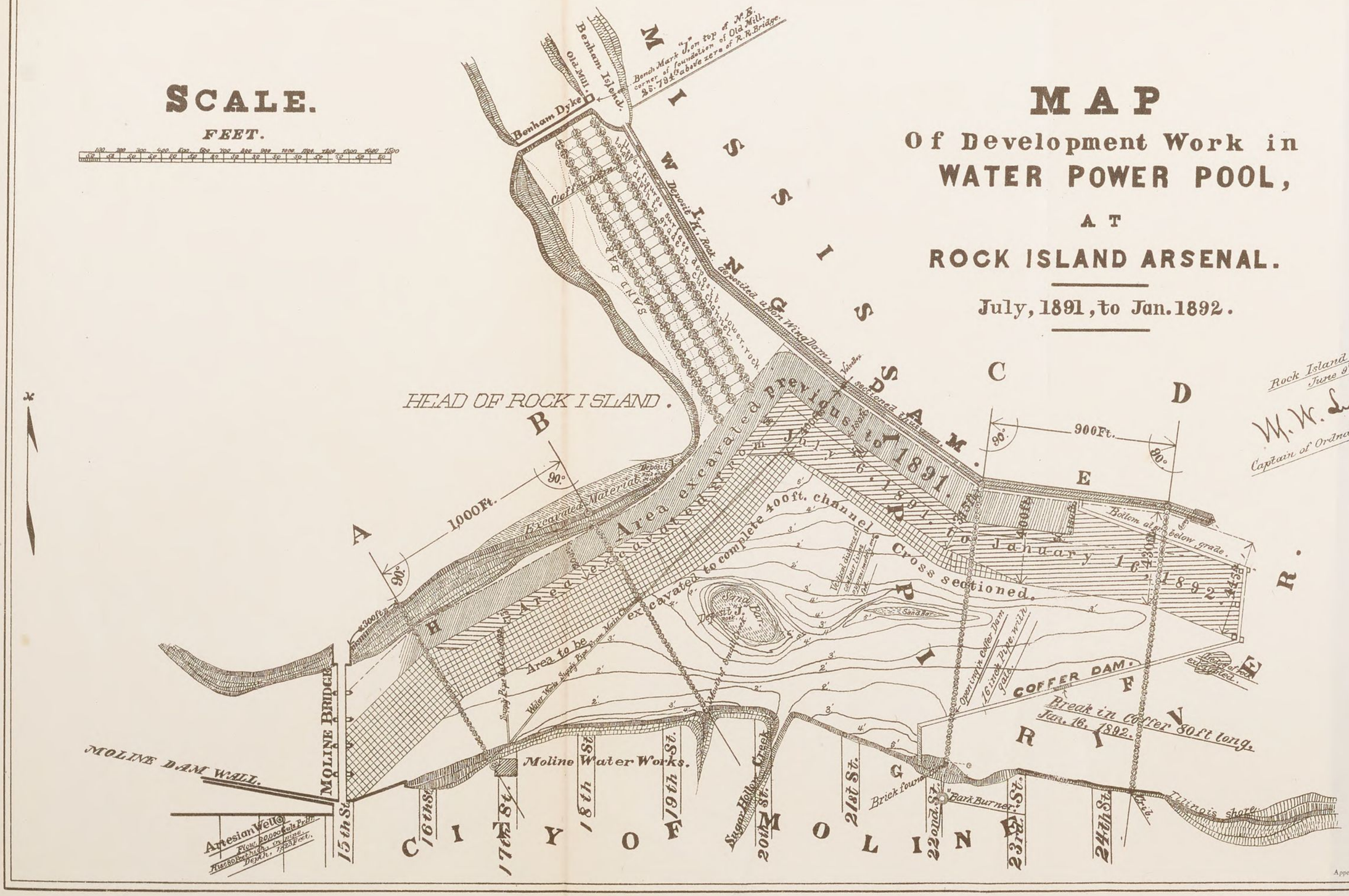
AT

ROCK ISLAND ARSENAL.

July, 1891, to Jan. 1892.

SCALE.

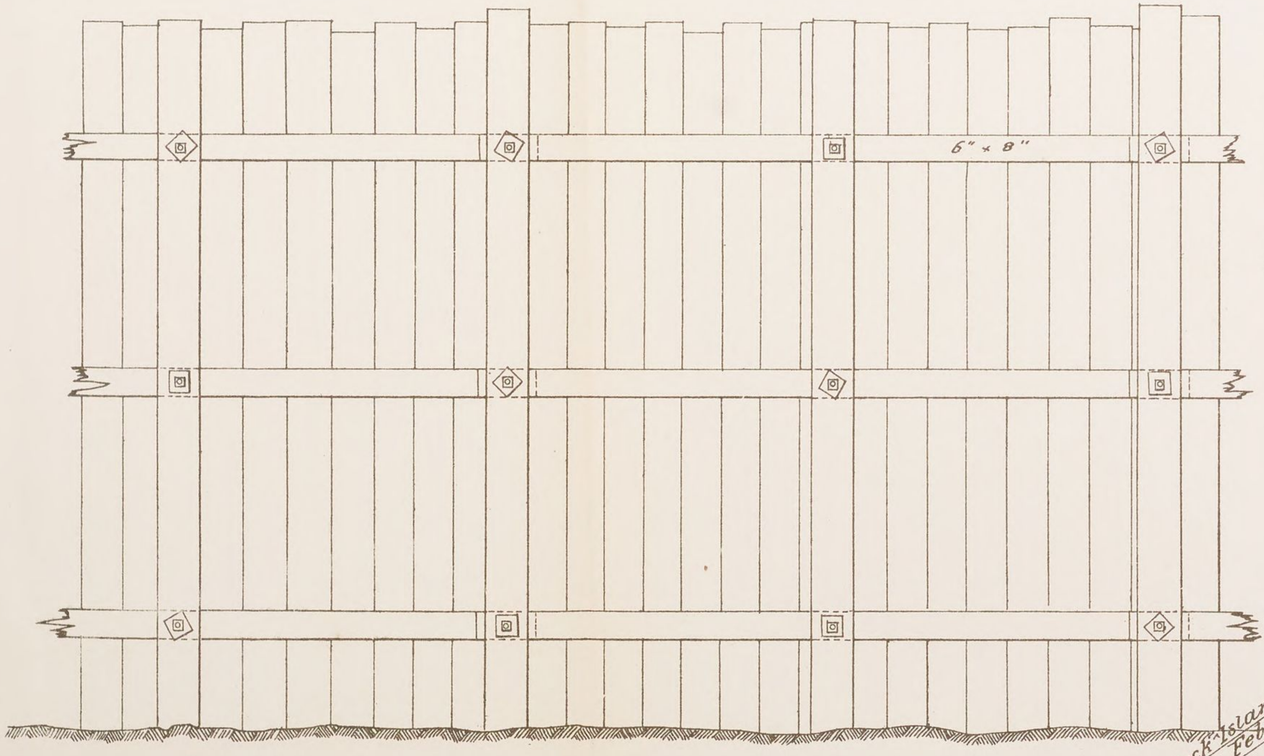
FEET.

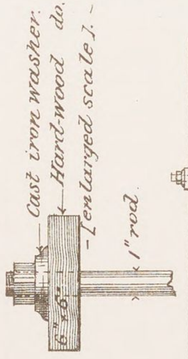

HEAD OF ROCK ISLAND.
MISSISSIPPI R.
Bench Mark "J" on top of N.E. corner of foundation of Old Mill. 25.79 ft above zero of R.R. Bridge.
Old Mill
Benham Island.
Benham Dyke
Clerk's Dam
Area excavated during Jan. 1892.
Area excavated previous to Jan. 1892.
Area to be excavated to complete 400 ft. channel
Cross sectioned.
Deposit of sand & clay
Deposit J.
Sand Bar
Sand Bar
Sand Bar

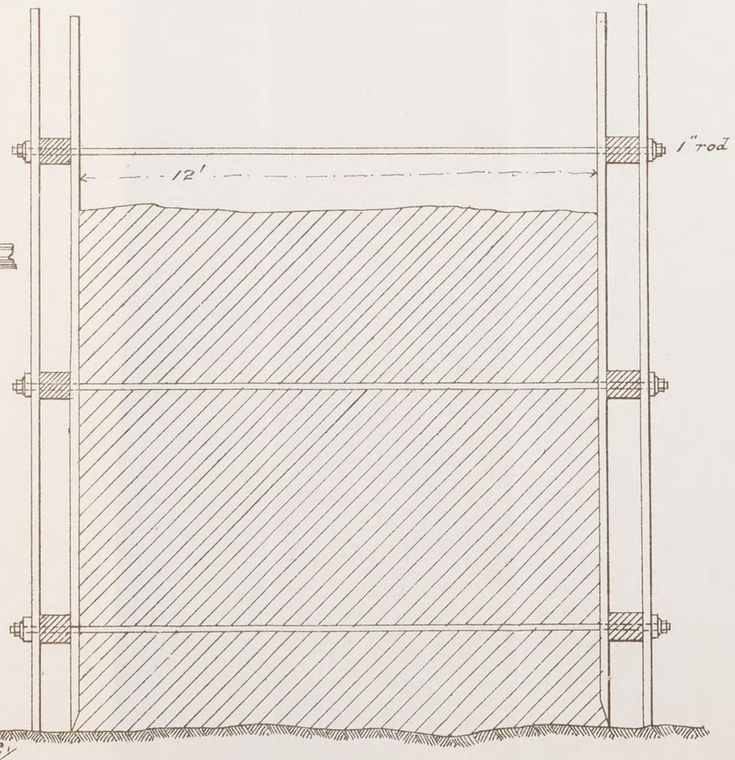
Elevation & Section of Coffer-Dam in Water Power Pool.
Rock Island Arsenal.

Scale: 0 5 10 15 Feet.

Note: In 10ft. coffer, 3/4 Inch rods were used.







Rock Island Arsenal.
Febr. 17th 1892.

W. W. Lyon.
Capt. of Ordnance.
U.S.A.
Comm.dg.

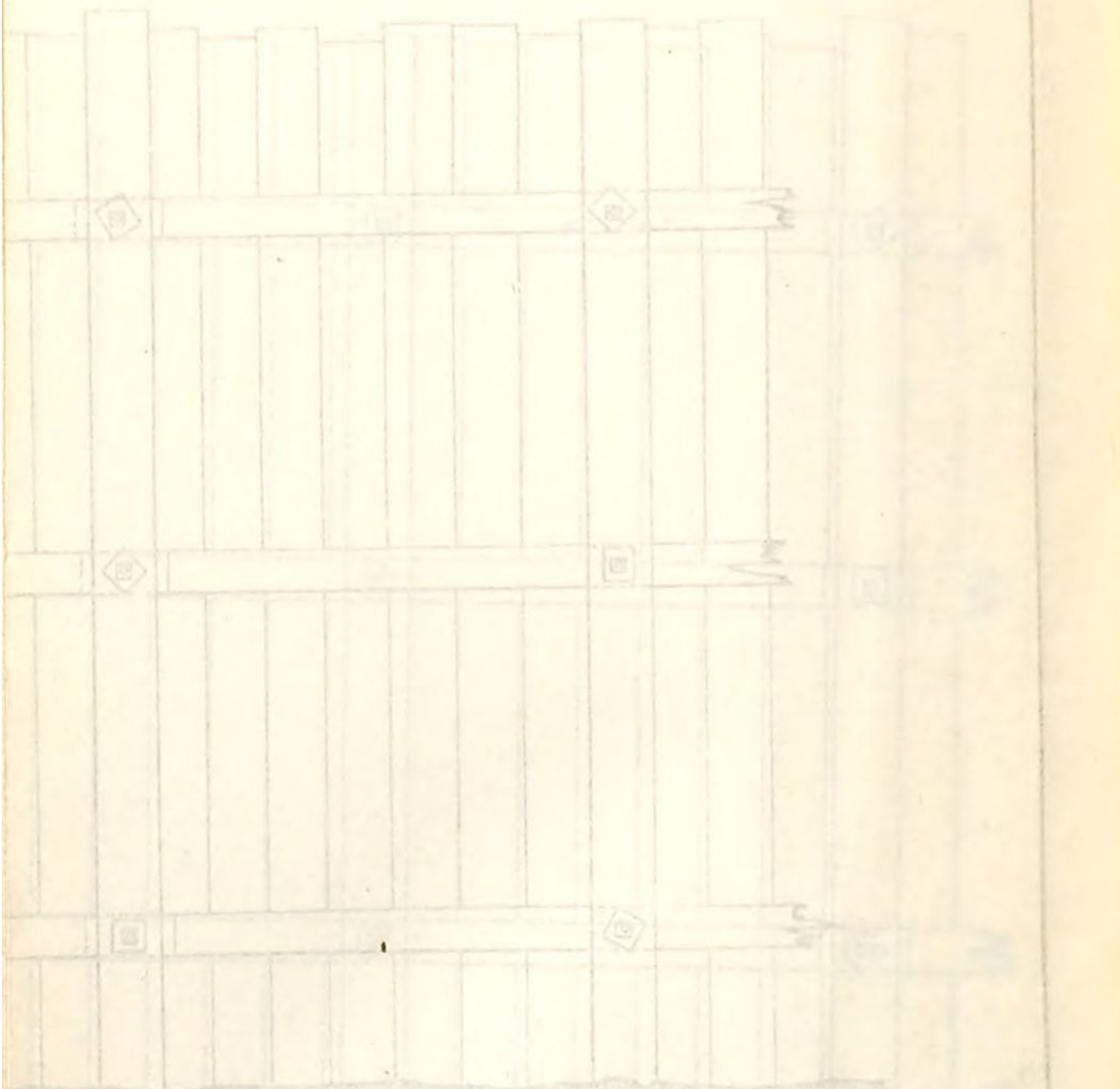


Table showing weekly excavations in bed of Water Power Pool, and where deposited.

Week ending	Mud excavated. Cub. yards.	Rock excavated. Cub. yards.	Total per week. Cub. yards.
Aug.t 29th " '91	40	10	50
Sept. 5 "	2571	—	2571
" 12 "	5272	—	5272
" 19 "	5997	1162	7159
" 26 "	4187	3809	7996
Oct. 3 "	3390	4016	7406
" 10 "	4937	2135	7072
" 17 "	4310	3491	7801
" 24 "	2390	5361	7751
" 31 "	1128	1546	2674
Nov. 7 "	1870	3284	5154
" 14 "	3819	3159	6978
" 21 "	1995	2478	4473
" 28 "	3732	2968	6700
Dec. 5 "	2356	4183	6539
" 12 "	2181	5389	7570
" 19 "	1540	3756	5296
" 26 "	1229	5204	6433
Jan. 2 '92	728	3291	4019
" 9 "	437	4821	5258
" 16 "	58	683	741
Total excavated.	54167	60746	114913
Excavation called for by Act of Congress.	24391	29466	53857
Surplus excavated.	29776	31280	61056

Where deposited:.			
Wing Dam.	1200	4250	5450
Sand Bar.	2440	2860	5300
Head of Island.	50527	53636	104163
Total.	54167	60746	114913.

Rock Island Arsenal, June 9th 1892.

W. S. Lyon,
Captain of Ordnance, U.S.A.

MAP
of
EXCAVATIONS
to
Complete Proposed Channel.

Scale, 100 50 0. 100. 200. 300. 400. 500 600. 700 800 900 Feet.

N.

City of Moline.

Moline Bridge.

Depth in feet of Earth Deposit, to Grade.

Stations, 25 feet.

City of Moline.

Moline Bridge.

Depth in feet of Rock Deposit, to Grade.

Stations, 25 feet.

Rock Island Arsenal,
June 9th 1892.

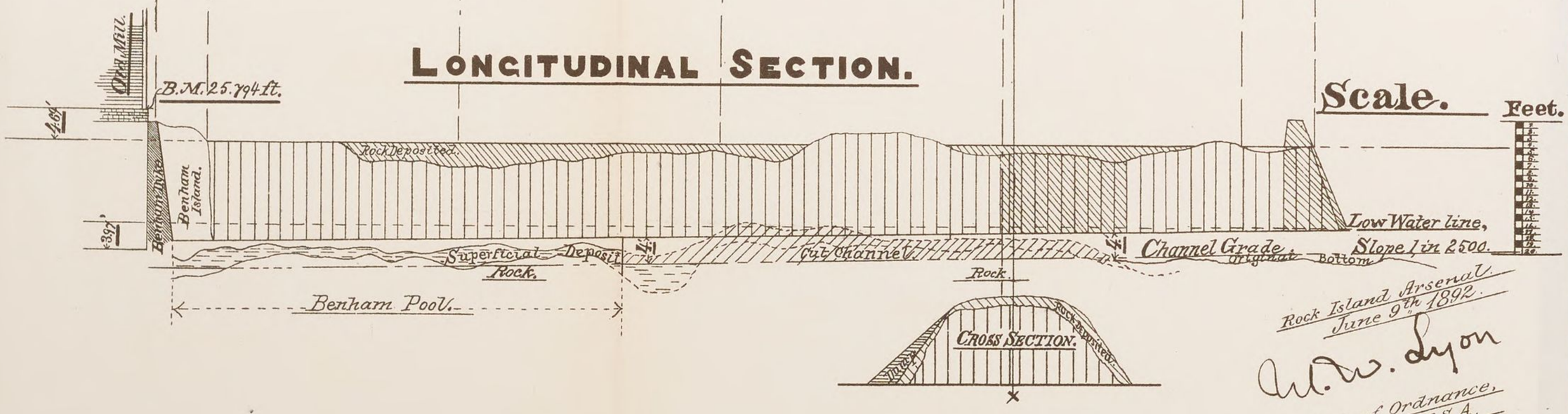
W. W. Lyon
Captain of Ordnance,
U.S.A.

Appendix 26, 1892.

WING DAM.

PLAN.

LONGITUDINAL SECTION.



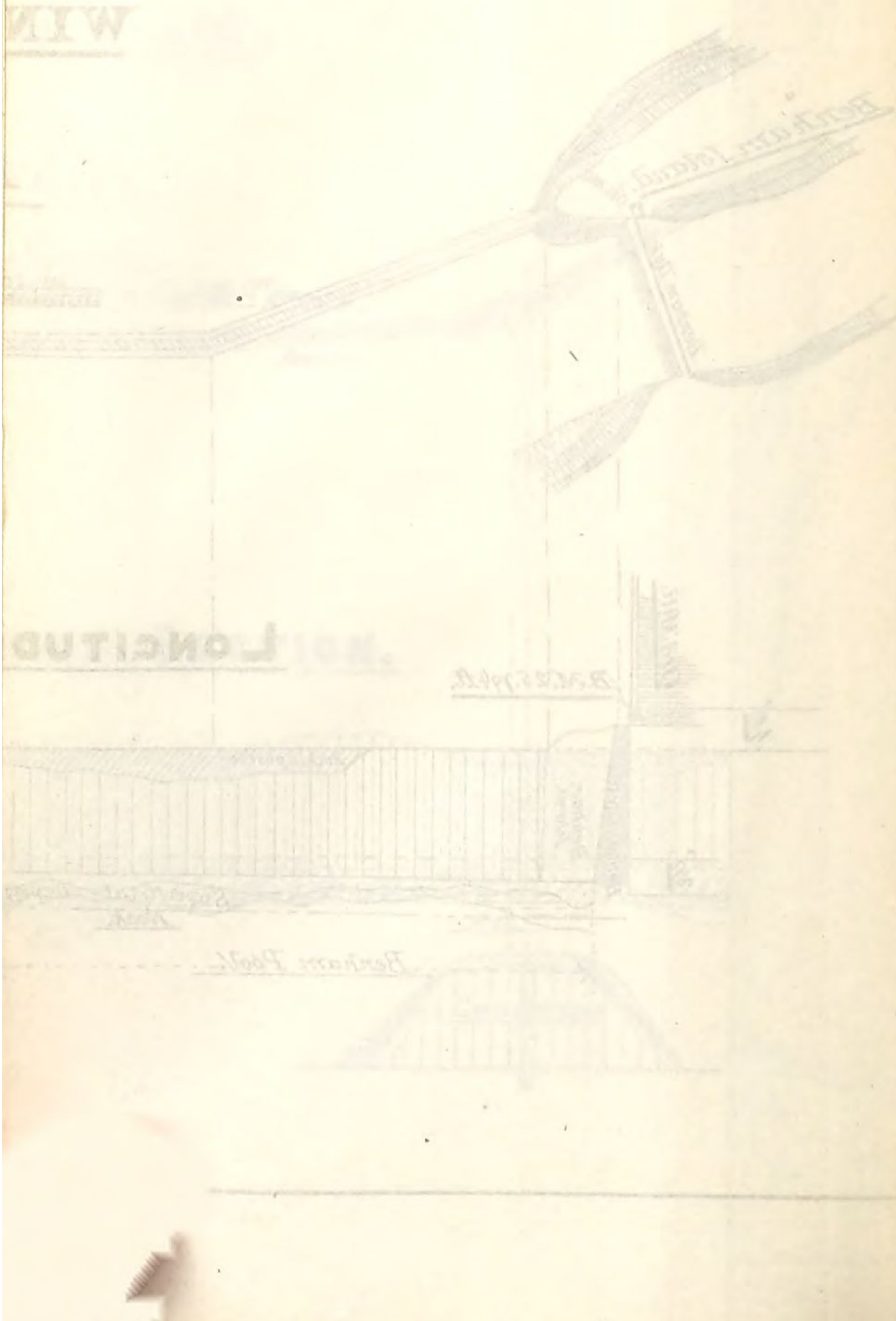
Rock Island Arsenal.
June 9th 1892.

W. W. Lyon

Captain of Ordnance,
U.S.A.

Appendix 26, 1892.

Ord 52 2



Stations.

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 30 31 32 33 34 35

Horizontal Scale.
Feet.
25 50 75 100 125 150 175 200 225 250 275 300 325

Vertical Scale.
Feet.

Station "0", a point 300 ft. east of N.E. corner of north abutment of Moline bridge. Measured on the dyke.

Station "35", top of foundation of N.W. corner of west wing of Moline Water Works.

Depth of cut to grade of channel, in feet.

A.

Channel. Superficial deposits. Limestone. Sandstone. Grade of cut channel.

Zero plane of gauge.

Station "0" dredge of dyke, upon a line parallel to line "A", 1000 ft. eastward.

Depth of cut to grade of channel.

Station 43, take near south of small creek.

B.

Grade of channel. Superficial deposits. Limestone. Sandstone.

Zero plane of gauge.

Station "0", upon Wing-Dam, at the point of its most acute angle.

Depth of cut to grade of channel.

Station 53, top of N.E. corner of old brick foundation, on a line from "0" station to "Bank Barner."

C.

Grade of channel. Superficial deposits. Sandstone. Sandstone.

Zero plane of gauge.

Station "0", upon Wing-Dam, 900 ft. east of zero station of line "C".

Depth of cut to grade of channel.

Station 53 plus 7 ft. top of crib in S. bank of river.

Note. Station 54 is 53 plus 7 ft.

D

Entrance to Canal. Crest of crib. Grade of channel. Superficial deposits. Sandstone. Sandstone.

Zero plane of gauge.

Rock Island Arsenal, June 9th 1892.
W. W. Lyon
Captain of Ordnance, U.S.A.

Cross Sections of Water-Power Pool at Rock Island Arsenal, on Lines A, B, C, D, of Plate 1.

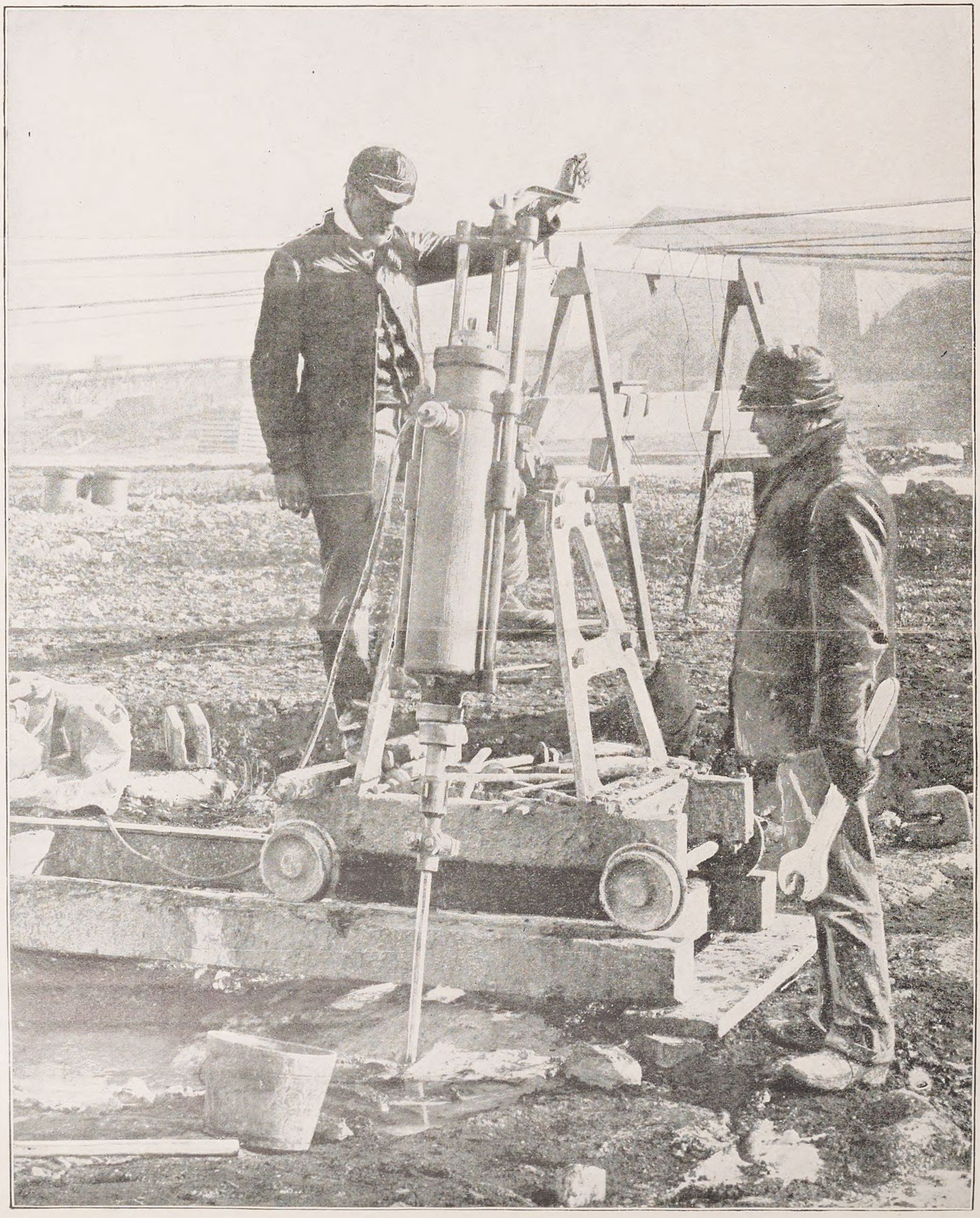
Appendix 26, 1892.

Ord 52 2

Cross Sections of Wagon

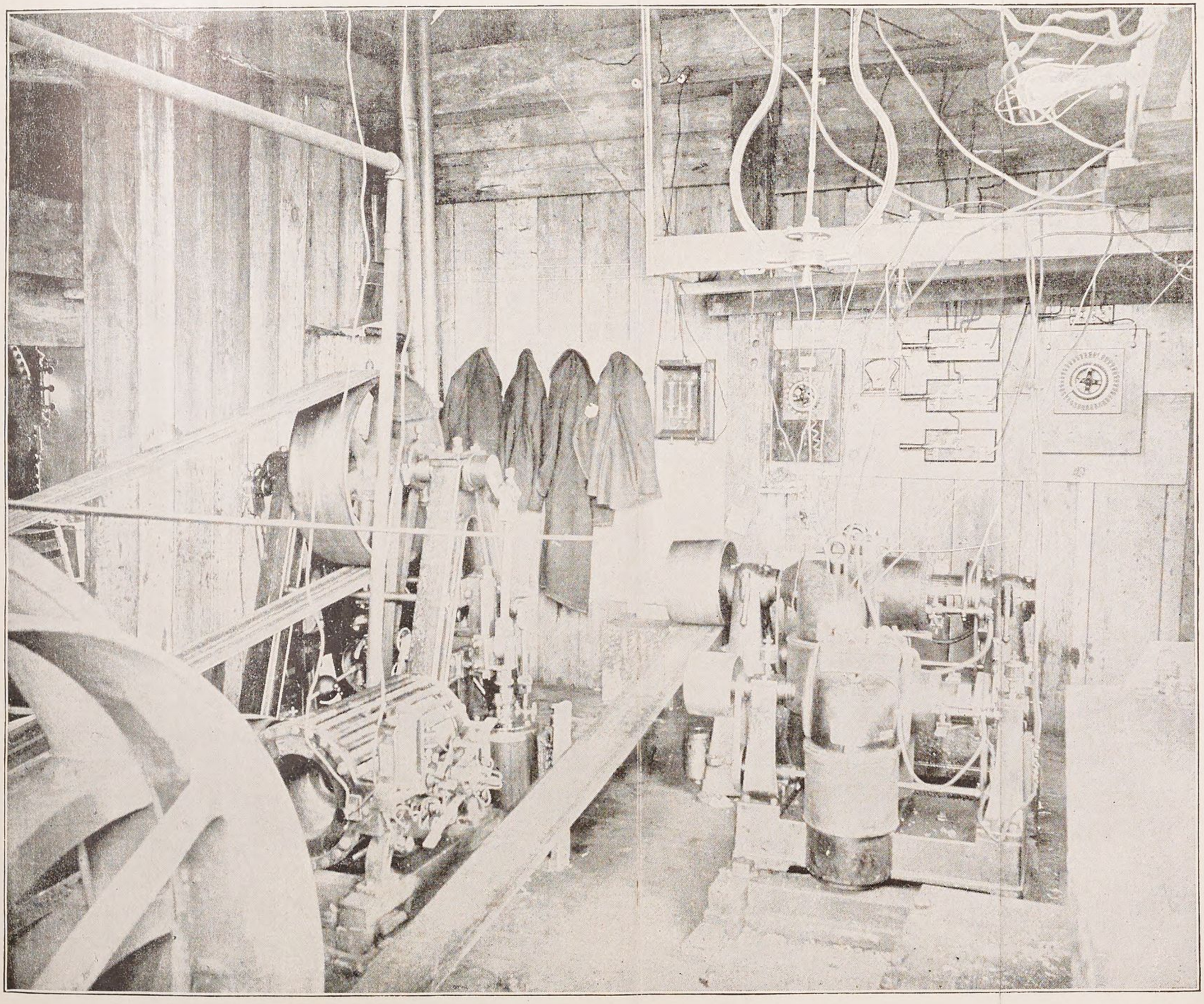
ELECTRIC DRILLS AT WORK.

SMALL ELECTRIC DRILL; FINISHING HOLE.



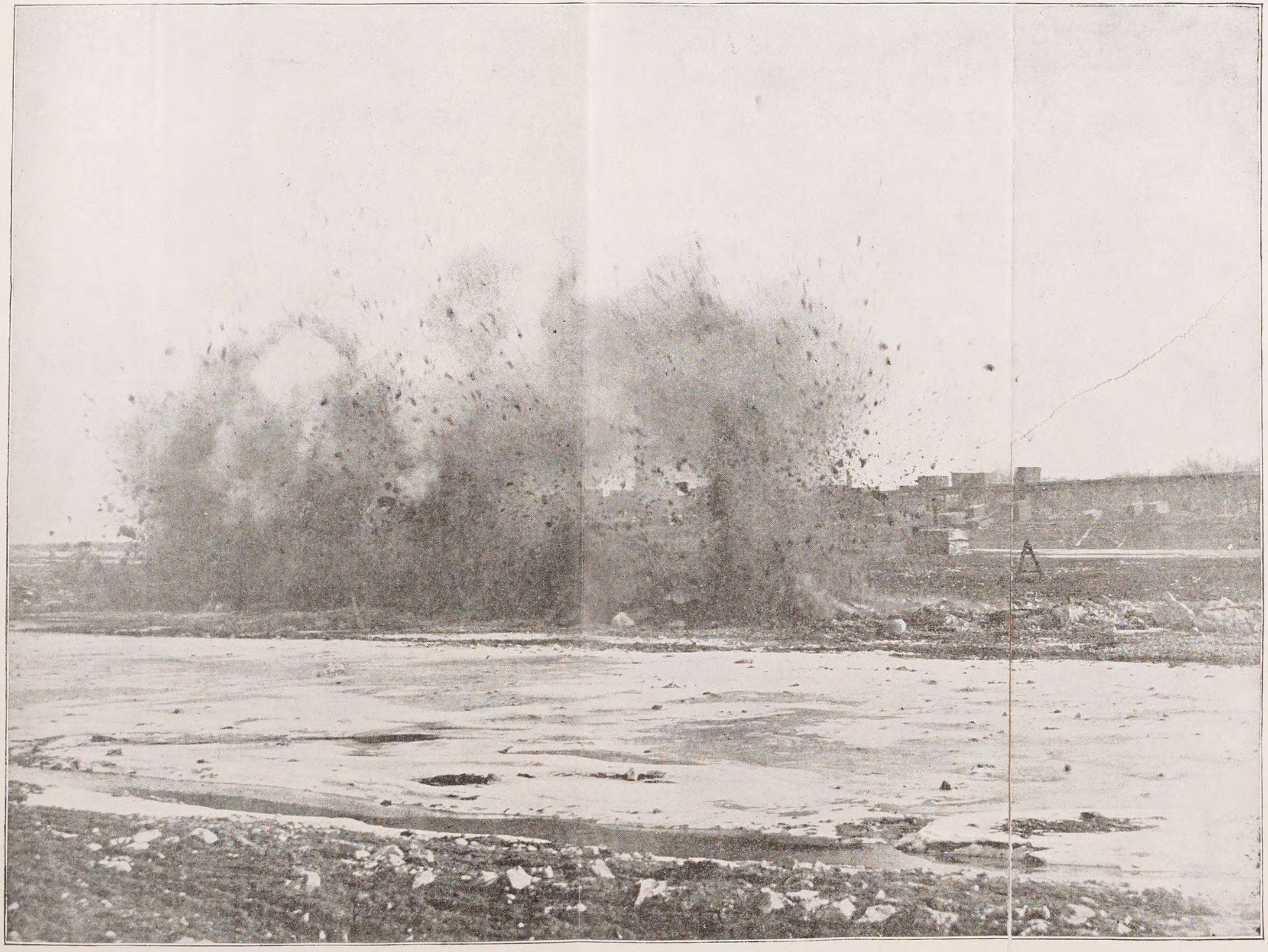
LARGE SIZE ELECTRIC DRILL.

EXCAVATED CHANNEL, PLUGGED HOLES, AND ELECTRIC DRILLS AT WORK.

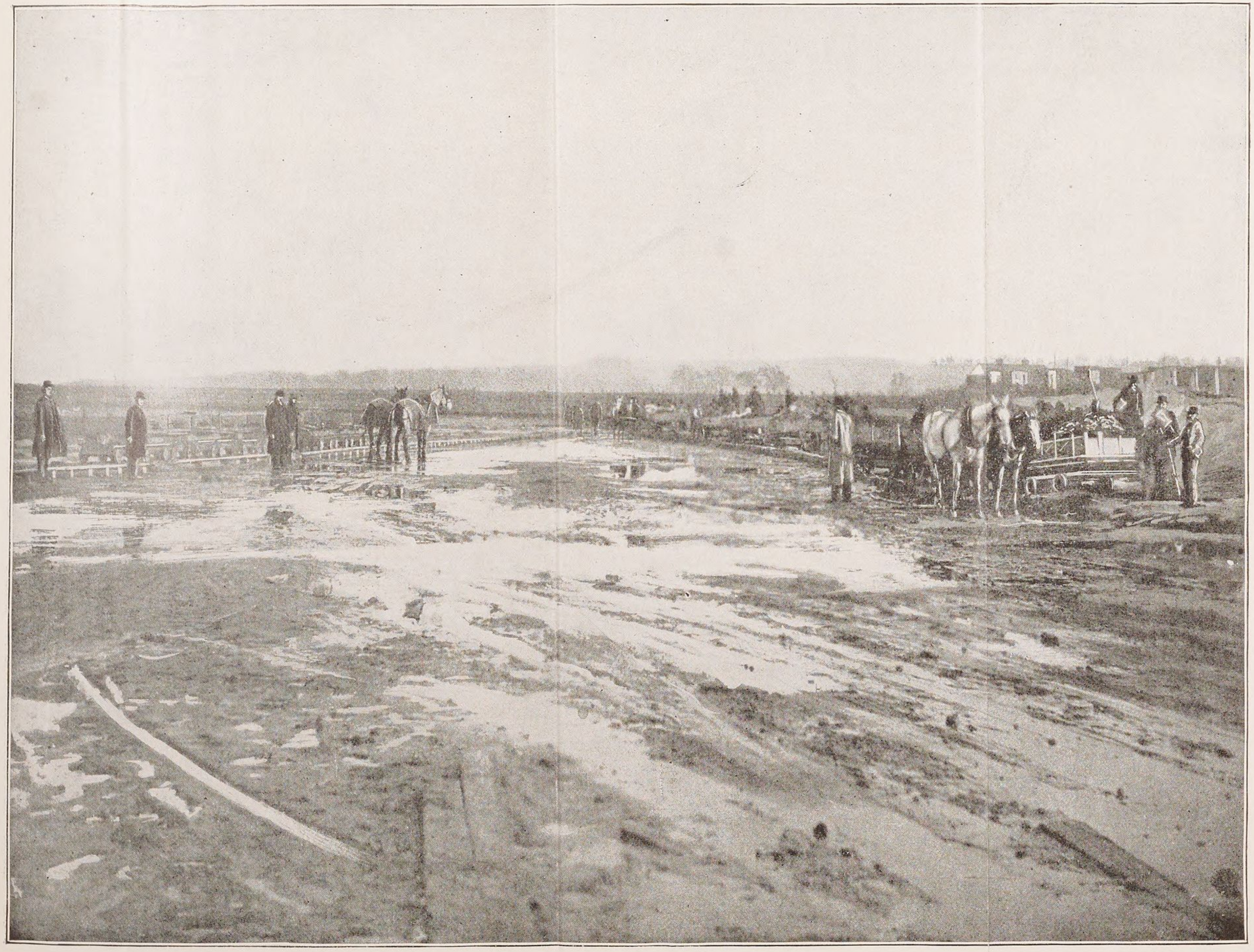


ELECTRIC POWER-HOUSE.

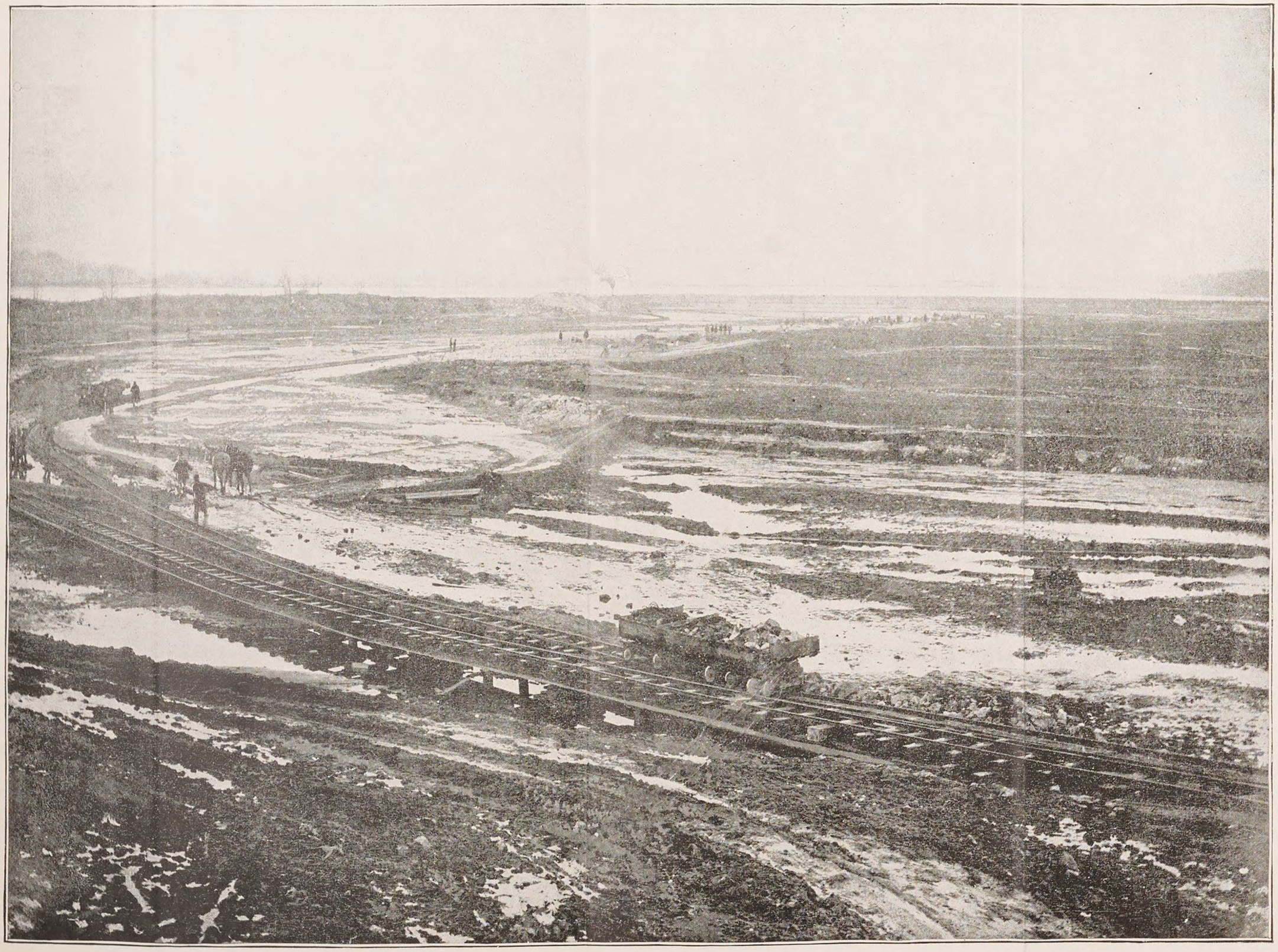
EXPLOSION OF 60 HOLES; CHARGE, 90 POUNDS DYNAMITE.



EXPLOSION OF 75 HOLES; CHARGE, 113 POUNDS DYNAMITE.



VIEW OF HEAD OF COFFER, SHOWING TRACKS AND CARS IN POOL.

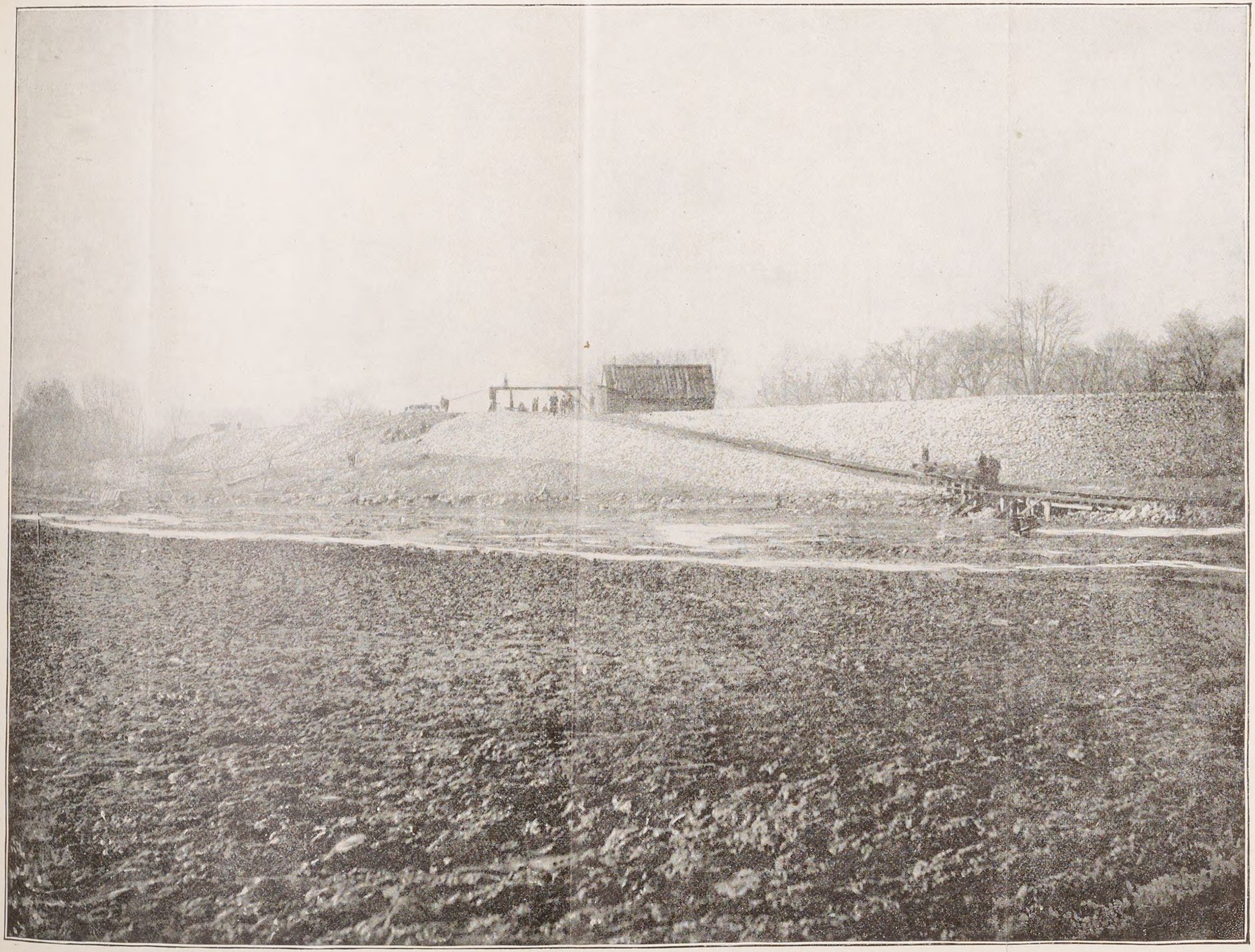


BIRD'S-EYE VIEW FROM HEAD OF ISLAND, SHOWING WORK IN POOL.

LOADING MATERIAL INTO CARS.

ROCK EXCAVATION NEAR MOLINE.

DUMP CARS IN BED OF POOL.



HAULING LOADED CARS OUT OF POOL.

APPENDIX 27.

DESCRIPTION OF MODIFIED PACKING OUTFIT FOR HOTCHKISS MOUNTAIN GUN, CALIBER 1.65, BY COL. A. R. BUFFINGTON, COMMANDING ROCK ISLAND ARSENAL.

(6 plates.)

The pack outfit for the Hotchkiss mountain gun consists of: 1 pack saddle for the gun and wheels (Pl. II); 1 pack saddle for the carriage and ammunition pack; 1 pack saddle for the ammunition (Pl. IV); 1 set of double harness (Pl. I); 1 harness sack; 1 pole and neck yoke (Pl. VI); 1 splinter bar; 4 ammunition boxes, holding 18 rounds each (Pl. III), and 1 ammunition pack, holding 6 rounds for use in an emergency (Pl. V).

PACK SADDLE.

The three saddles are identical, with the exception of the yokes, for carrying the different parts, and a few minor changes in the pads. The first is designed to carry the gun and the wheels of the carriage; the second to carry the gun carriage, the pole, the splinter bar, the harness sack, containing the harness and the pole yoke, and the ammunition pack, while the third is to carry the four ammunition boxes. They are composed of two wooden side bars 23 inches long, joined together by two metal yokes; these are placed 18 inches from center to center in the carriage and ammunition saddles, and $17\frac{7}{8}$ inches from center to center in the gun saddle, being riveted to the side bars by $\frac{1}{4}$-inch iron rivets. On each neck yoke of the ammunition pack saddle is bolted a steel spring 76 inches long; to these are riveted six clips to hold boxes in position when cargo cincha is removed, each clip having a strap to pass around the boxes. Two cotton-duck pads 23 inches wide, faced with leather on the sides and top, form the sides of the saddle. These pads are stuffed with tow and graduated in thicknesses, in front from $3\frac{1}{2}$ inches on bottom to $2\frac{1}{4}$ inches on top, and in rear from 3 inches on bottom to $1\frac{1}{4}$ inches on top; these are tufted and laced to saddle skirt with rawhide thongs and screwed securely to the side bars. The top of the pad of the carriage saddle is stuffed high on the rear off side, so as to raise the pole that it will not strike the animal; two straps are also riveted on the near-side pad for strapping on the harness sack with its load, and two straps are riveted on the off side for strapping on the pole and splinter bar; the near-side pad of ammunition pack is left slack through the center, so that the latigo iron will imbed itself and not interfere with the ammunition boxes. A welt, $\frac{5}{8}$ inch wide, is sewed between the edges of the pad where joined together, and an ash stick, 21 inches long by $1\frac{7}{8}$ inches wide and $\frac{3}{4}$ inch thick, is fastened to the pads by leather sockets for the latigo strap to work over. Underneath

all the pads in front is a spring of steel, 13¼ inches long, ⅝ inch wide, and ⅛ inch thick, and underneath the rear is riveted a steel spring 10½ inches long, 1 inch wide, and ⅛ inch thick. Attached to the under side of the saddle pads are two skirts of heavy harness leather with holes punched through for lacing to the pads and for attaching the crupper by means of lacings. The saddle cincha is the same for all saddle packs, and is made of two thicknesses of cotton duck, 10 inches wide, with latigo iron and chape sewed on each end; a latigo strap sewed into iron at one end; a circular piece of leather 3¾ inches in diameter with leather thong for fastening latigo strap after lashing on saddle is sewed on cincha 13 inches from the latigo end of the strap. The crupper is composed of two leather side pieces and one dock; the side pieces are lined with light leather and sewed together, being reinforced on the ends with strips of leather 2 inches wide, through which are punched holes for lacing to the saddle skirt. The dock is sewed around center and stuffed, the ends being sewed on to the side pieces.

The cargo cincha is made of two thicknesses of cotton duck 10 inches wide, with latigo irons and straps on each end. The one for the carriage pack is made 52 inches long and faced in center with leather, which has a slot 10 inches long by 1½ inches wide for passing over the elevating screw, and is screwed on block which fits between the flanges of the trail of the carriage. The one for the gun pack is made 59 inches long and faced with leather, which is left long enough to make chapes for latigo irons, and with a slot in the center to pass over the trunnions; sewed on each side to support the wheels are two pads of leather 3¼ inches wide. For the ammunition pack the cargo cincha is made 58 inches long with latigo irons and straps, but without facings. The belly cincha is made of three thicknesses of cotton duck 7½ inches wide, with a D-ring and chape sewed on each end. The one used with the gun pack has also two straps with buckles and billets sewed on each chape for securing the wheels in position.

A semicircular pad 3 inches in diameter and 3¼ inches high, stuffed with tow, is strapped on gun near rear end, to protect it from the wheels

A hub strap for holding weight of wheels on gun is made in two pieces; the end of one contains a 1¼-inch buckle, and an end of the other forms a billet for buckling the two together. The ends of both are doubled and sewed, forming a loop for passing over the hubs of the wheels. Wheel straps for securing wheels together at top are made with 1-inch buckles at one end. Trail straps are made with 1⅛-inch buckles at one end and are buckled on trail around sponge and rammer clasp.

The gun pad, the hub strap, and the wheel straps, though not fastened to the gun-pack saddle, are parts of it. In the same way the trail straps are a part of the carriage pack saddle.

HARNESS.

The bridle is composed of 1 headstall, 1 pair reins, and 1 bit. The headstall consists of 1 crown piece, split 7 inches on each end, forming cheek piece and throat latch billets; 2 cheeks, made by folding and sewing each strap together, making a fold 9½ inches long, containing therein two ¾-inch buckles, and five loops, the remainder of the strap forming a billet for attaching the bit; 1 brow band, the ends doubled and sewed, forming two loops, through which pass the cheek and throat-latch billets; 1 throat latch, the ends doubled and sewed, each end con-

taining one $\frac{5}{8}$-inch buckle and 1 loop; 2 reins, sewed together at one end and the other ends having $\frac{7}{8}$-inch buckles, and billets sewed on for attaching to bit; 1 bit (malleable iron) with loose rings $2\frac{5}{8}$ inches in diameter and jointed mouth piece.

Breast collar composed of 1 body, 1 shoulder strap, and 2 neck straps, 1 neck-strap billet and collar strap. The body is made of single leather, with under edges reduced so as not to chafe the animal; 1 chape, with a $1\frac{1}{4}$-inch iron ring sewed and riveted on center; 1 lay, with a tug sewed on each side 17 and 24 inches from each end of body; 2 iron buckles, $1\frac{1}{4}$ inches, and chapes with 2 loops sewed on body from each end for projection to make a safe; 1 strap, split up on each end 15 inches, forming the shoulder straps, and also split up $17\frac{1}{2}$ inches for buckling on the neck strap, making $\frac{3}{4}$-inch billets for buckling into tugs on body and into neck straps; 2 neck straps, one end of each doubled and sewed, containing one $\frac{3}{4}$-inch buckle and loop, the other end sewed and riveted to billet connecting with buckle on neck-yoke strap; 1 collar strap for supporting martingale, sewed into ring on body of breast collar; 4 tugs, made of two thicknesses of leather and sewed together, each containing two loops, a $\frac{3}{4}$-inch buckle, and $\frac{7}{8}$-inch ring; back straps sewed on center of shoulder strap, with holes punched to buckle into tug on breeching.

Traces, single thickness, with iron clip riveted on one end, the other end punched for buckling into breast collar.

Martingale, single thickness, with $1\frac{1}{2}$-inch buckle, sewed on one end, turned back and buckled into body, forming a loop to pass over neck yoke; on the other end is sewed and riveted a $1\frac{1}{2}$-inch D-ring with safe, for connecting with side straps on breeching. On body of martingale is sewed a strap containing a $\frac{3}{4}$-inch buckle and loop for the collar strap to buckle into.

Breeching composed of 1 body, 4 tugs, 2 hip straps, 1 back-strap tug. The body has its under edges reduced and on it are sewed two lays containing $1\frac{1}{2}$-inch breeching rings and $\frac{7}{8}$-inch tug rings.

The tugs are made of two thicknesses of leather, each contains three loops and a $\frac{3}{4}$-inch buckle; these are sewed—two in the breeching rings and one in a $\frac{7}{8}$-inch ring on the body under lays.

The hip straps are split $16\frac{1}{2}$ inches from one end; the other end sewed into the ring of back-strap tug.

The back-strap tugs are made double thickness, with 1-inch buckles, $1\frac{1}{2}$-inch rings and loop sewed on safe.

Side straps are made of single thickness, one end folded and sewed, containing a 1-inch buckle; the other end punched for buckling; side strap when buckled up contains a 1-inch hook for attaching to D-ring on martingale.

Pole strap made of single thickness, one end folded and sewed, containing a $1\frac{1}{4}$-inch buckle, and the other end punched for buckling; a loop is placed on top and bottom of fold.

HARNESS SACK.

The harness sack is made of cotton duck, and consists of one body and two side pieces, which when sewed together form a sack 33 inches long, 12 inches wide, and 7 inches deep, with four flaps to cover the harness; two leather billets are sewed on top and two chapes, containing $\frac{3}{4}$-inch buckles and loops, are sewed on body. In this are carried the harness, neck yoke, and splinter bar.

POLE.

The pole is of hickory, 6 feet 2½ inches long, 2½ inches square at rear end, and 1½ inches round at front end; at the rear end is an iron loop with a pintle pin to receive the lunette of the trail of gun carriage; at the front end is an iron stud pin for neck-yoke stop. The pole is hinged 2 feet 6 inches from the front end, and can be doubled under, which makes it more convenient for packing; when the pole is straightened out for use, a sliding ferule is slipped over hinge, which holds it firmly in place.

NECK YOKE.

The neck yoke is of hickory, 3 feet and 2 inches long, 1¾ inches round at center and 1⅛ inches round at each end. Fitted to the center is the neck-yoke brace, made of double thickness of leather, sewed together part way, leaving an opening large enough to admit the neck yoke, and through the double part is worked the hole to fit over the pole of the carriage. A billet is placed on top of brace and both are secured to the neck yoke by a ¾-inch No. 8 round-headed screw. At each end is riveted an iron staple, through which the pole straps pass.

SPLINTER BAR.

The splinter bar is made of hickory, 56 inches long; the center is 2 by 1½ inches, and the ends are oval, 1 by 1¼ inches; 3 feet from the center each way are placed two iron eyelet straps to receive the hooks on the side of the gun-carriage trail. At each end and 24 inches from each end are placed iron bands with tug hooks for attaching the traces of the harness.

AMMUNITION BOXES.

The ammunition box is made of pine, 24 inches long, 8 inches wide, and 8 inches deep, with sliding cover at each end; the covers are connected to the box by a lifting hinge, so they can not be lost; when in place they are each strengthened by a piece of $\frac{3}{16}$-inch wire, one piece being placed on the outside of the cover and fastened to the side of the box, and the other piece is let into a groove cut across the cover and passed through the sides of the box and fastened at one end by a spring on the sides of the box. This piece of wire must be removed before the cover can be opened. The interior of the box is arranged for 18 cartridges, 9 in each end; for this purpose two partitions are placed in each end with holes bored in them to fit the cartridges, and one partition countersunk on both sides, to receive the ends of the cartridges, is placed in the center of the box. In the space between the cartridges in each end of the box there is ample room for carrying friction primers, if packed 10 in a bunch. The under side of the box has an indentation to allow it to fit over the clips on the springs of the ammunition pack-saddle, so when the cargo cincha is removed the boxes will remain in position. One handle of wrought iron is fastened with screws to the outside of each cover for ease in handling when the boxes are unpacked.

AMMUNITION PACK.

The ammunition pack is composed of 2 bodies, 1 connecting piece, 1 carrier strap with 1-inch buckle, 2 cartridge loops, 2 block straps, and 2 blocks. The bodies and carrier strap are sewed and riveted to the connecting piece, and the cartridge loops for holding 3 cartridges each are sewed and riveted to the bodies, all being made of leather. The wooden blocks are secured in place by block straps fastened with brass screws.

Cost of packing outfit for Hotchkiss mountain gun.

Pack saddle for gun	$44.16	
Crupper	4.10	
Belly cincha	4.85	
Saddle cincha	3.89	
Cargo cincha	9.24	
Wheel straps	.17	
Hub straps	.40	
Gun pad	1.30	
Lashing rope	.25	
		$68.36
Pack saddle for carriage	41.44	
Crupper	4.10	
Belly cincha	3.63	
Saddle cincha	3.89	
Cargo cincha	6.45	
Trail strap	.14	
Lashing rope	.25	
		59.90
Pack saddle for ammunition	48.94	
Crupper	4.10	
Belly cincha	3.63	
Saddle cincha	3.89	
Cargo cincha	3.92	
Lashing rope	.25	
		64.73

Harness.

Bridles, 2 at $1.92	3.84	
Breast collars, 2 at $2.72	5.44	
Martingales, 2 at 77 cents	1.54	
Breeching, 2 at $3.61	7.22	
Traces, 2 pairs at $1.30	2.60	
Pole straps, 2 at 26 cents	.52	
		21.16
Harness sack		1.26
Neck yoke	.75	
Neck-yoke brace	.40	
Neck-yoke brace billet and chapes	.12	
		1.27
Pole		41.21
Splinter bar	7.51	
Trail hooks for attachment of splinter bar	1.60	
		9.11
Ammunition boxes, 4 at $3.18	12.72	
Cartridge pack	2.54	
Total		282.26

NOTE.—A modification from the model carriage originally furnished has been observed in some of the carriages constructed since, and this variation can not be provided for in the pack saddle. The angle irons at the bottom of the body of these modified carriages are prolonged to the axle seat in some cases at both sides; in other cases they are prolonged at one side and in both cases extend farther than in the

model. These irons prevent such carriages from falling into place in the saddle. No remedy can be devised in constructing the saddle, and the angles of the modified carriages must be cut away to correspond with the model for which the saddle was designed. All carriages in service that will not fit these saddles will have to be returned to Rock Island Arsenal for alteration.

(7904–'92.)

Bill of materials for one Hotchkiss packing outfit.

Name of parts.	Number.	Weight.	Length. Cut.	Length. Finished.	Width.	Buckles. Number.	Buckles. Width.	Material.
One pack saddle for gun and wheels.		*Lbs.*	*In.*	*In.*	*In.*		*In.*	
Metal yokes, japanned	2	5½	------	------	------	----	------	Gun metal.
Metal trunnion plates	2	¼	------	------	------	----	------	Do.
Side pieces for trunnion plates, japanned.	2	------	20	------	------	----	------	⅛-inch thick steel.
Springs for pads, front	2	------	13¼	13¼	⅝	----	------	Do.
Springs for pads, rear	2	------	10½	10½	1	----	------	Do.
Iron rivets, flat head	22	------	3	------	------	----	------	¼-inch iron, round.
Iron rivets, round head	8	------	1	------	------	----	------	Do.
Saddle bars	2	------	24	23	7	----	------	3-inch poplar.
Cross pieces	2	------	22	21	1⅞	----	------	1-inch ash.
Saddle cincha	1	------	65	64	22	----	------	No. 1 cotton duck.
Latigo strap	1	------	90	87	1¼	----	------	Harness leather.
Circular piece, ¾ inch diameter	1	------	------	------	------	----	------	Do.
Chapes	2	------	8¾	4⅞	10	----	------	Do.
Lacings	1	------	18	18	¼	----	------	Lace leather.
Metal frames	2	1	------	------	------	----	------	Gun metal.
Cargo cincha	1	------	59½	58½	22	----	------	No. 1 cotton duck.
Latigo straps	2	------	88	85	2	----	------	Harness leather.
Pads	4	------	16½	10	9¼	----	------	Collar leather.
Slot lining	2	------	8	8	4	----	------	Do.
Facing and chapes	1	------	67	59	10	----	------	Harness leather.
Metal frames	2	1¼	------	------	------	----	------	Gun metal.
Blocks	4	------	10	10	2⅞	----	------	1 inch thick poplar.
Belly cincha	1	------	20	19	22½	----	------	No. 1 cotton duck.
Chapes	2	------	9½	4¾	5½	----	------	Harness leather.
Billets for securing wheels	4	------	36	36	1½	4	1½	Do.
Chapes for securing wheels	4	------	10½	8	1½	----	------	Do.
D-rings	2	------	18	------	------	----	------	½-inch iron, round.
Saddle pads	2	------	46	23	25	----	------	No. 1 cotton duck.
Tow	----	18	------	------	------	----	------	
Skirts ..... pairs	1	------	17¼	17¼	25¾	----	------	Harness leather.
Under cover ..... do	1	------	10½	10½	25	----	------	Do.
Facings on front	2	------	41½	41½	3	----	------	Do.
Facings on rear	2	------	46	46	4	----	------	Do.
Facings on top	2	------	25¼	25	3	----	------	Do.
Sockets	4	------	6½	------	6	----	------	Collar leather.
Sockets, reënforce	4	------	5¼	------	4¼	----	------	Do.
Lacings	4	------	72	72	¼	----	------	Lace leather.
Side pieces for crupper	2	------	23	23	11½	----	------	Collar leather.
Linings for crupper	2	------	22	21½	12½	----	------	Do.
Reënforce for crupper	2	------	11½	11½	2	----	------	Harness leather.
Docks for crupper	1	------	10¾	10¾	7½	----	------	Do.
Facings for crupper	2	------	72	72	¼	----	------	Lace leather.
Straps for securing wheels	1	------	20½	18	1	1	1	Harness leather.
Hub straps, body	1	------	31	22½	1¼	1	1¼	Do.
Hub straps, billet	1	------	31	20	1¼	----	------	Do.
Lashing rope	1	------	240	240	------	----	------	⅜-inch manila rope.
Top for gun pad	1	------	25	------	3	----	------	Collar leather.
Sides for gun pad	2	------	10½	------	5¾	----	------	Do.
Bottoms for gun pads	1	------	19	------	3	----	------	Do.
Tow	----	2	------	------	------	----	------	
One pack saddle for carriage.								
Metal yokes, japanned	2	5½	------	------	------	----	------	Gun metal.
Springs for pads, front	2	------	13¼	13¼	⅝	----	------	⅛-inch thick steel.
Springs for pads, rear	2	------	10½	10½	1	----	------	Do.
Iron rivets, flat head	22	------	3	------	------	----	------	¼-inch iron, round.
Saddle bars	2	------	24	23	7	----	------	3-inch poplar.
Cross pieces	2	------	22	21	1⅞	----	------	1-inch ash.
Straps for securing harness	2	------	42	40	⅞	2	⅞	Harness leather.
Straps for securing pole and splinter bar, front.	1	------	41	39	1	1	1	Do.
Straps for securing pole and splinter bar, rear.	1	------	45	43	1	1	1	Do.

Bill of materials for one Hotchkiss packing outfit—Continued.

Name of parts.	Number.	Weight.	Length.		Width.	Buckles.		Material.
			Cut.	Finished.		Number.	Width.	
		Lbs.	*In.*	*In.*	*In.*		*In.*	
Saddle cincha	1	.....	65	64	22	....	.....	No. 1 cotton duck.
Latigo strap	1	.....	90	87	1¼	....	.....	Harness leather.
Circular pieces, ¾ inch diameter	1	.....	.....	.....	.....	....	.....	Do.
Chapes	2	.....	8¾	4⅞	10	....	.....	Do.
Lacings	1	.....	18	18	¼	....	.....	Lace leather.
Metal frames	2	1	.....	.....	.....	....	.....	Gun metal.
Cargo cincha	1	.....	52	51	22	....	.....	No. 1 cotton duck.
Latigo straps	2	.....	88	85	2	....	.....	Harness leather.
Chapes	2	.....	8¾	4⅞	10	....	.....	Do.
Facings	1	.....	13	13	10	....	.....	Collar leather.
Slot lining	1	.....	12¼	.....	3½	....	.....	Do.
Metal frames	2	1¼	.....	.....	.....	....	.....	Gun metal.
Elevating screw block	1	.....	8	.....	10	....	.....	6-inch thick pine.
Belly cincha	1	.....	20	19	22½	....	.....	No. 1 cotton duck.
Chapes	2	.....	9½	4¾	5½	....	.....	Harness leather.
D-rings	2	.....	18	.....	.....	....	.....	½-inch round iron.
Saddle pads	2	.....	46	23	25	....	.....	No. 1 cotton duck.
Tow	....	18	.....	.....	.....	....	.....	
Skirts ..... pairs	1	.....	17½	17¼	25¾	....	.....	Harness leather.
Under covers ..... do	1	.....	10½	10½	25	....	.....	Do.
Facings on front	2	.....	41½	41½	3	....	.....	Do.
Facings on rear	2	.....	46	46	4	....	.....	Do.
Facings on top	2	.....	25¼	25	3	....	.....	Do.
Sockets	4	.....	6½	.....	6	....	.....	Collar leather.
Sockets, reënforce	4	.....	5¼	.....	4¼	....	.....	Do.
Lacings	4	.....	72	72	⅛	....	.....	Lace leather.
Side pieces for crupper	2	.....	23	23	11½	....	.....	Collar leather.
Linings for crupper	2	.....	22	21½	12½	....	.....	Do.
Reënforce for crupper	2	.....	11½	11½	2	....	.....	Harness leather.
Docks for crupper	1	.....	10¾	10¾	7½	....	.....	Do.
Lacings for crupper	2	.....	72	72	¼	....	.....	Lace leather.
Trail strap	1	.....	16	14	1⅛	1	1⅛	Harness leather.
Lashing rope	1	.....	240	240	.....	....	.....	⅜-inch manila rope.
One pack saddle for ammunition.								
Metal yokes, japanned	2	2½	.....	.....	.....	....	.....	Gun metal.
Springs for pads, front	2	.....	13¼	13¼	⅝	....	.....	⅛-inch steel.
Springs for pads, rear	2	.....	10½	10½	1	....	.....	Do.
Springs for ammunition boxes, japanned.	2	.....	76	76	1¼	....	.....	Do.
Clips for ammunition boxes, japanned.	8	.....	4	.....	1¾	....	.....	Do.
Do	2	.....	2	2	1¾	....	.....	Do.
Do	1	.....	8	8	1¾	....	.....	Do.
Iron rivets, flat head	22	.....	3	.....	.....	....	.....	¼-inch iron, round.
Metal wedge rests	4	1	.....	.....	.....	....	.....	Gun metal.
Round-head bolts	2	.....	1½	.....	.....	....	.....	¼-inch iron, round.
Straps for ammunition boxes	4	.....	28	26⅛	1	4	1	Harness leather.
Billets for ammunition boxes	4	.....	16	16	1	....	.....	Do.
Buckle pieces for ammunition boxes.	4	.....	13½	11⅝	1	4	1	Do.
Saddle cincha	1	.....	65	64	22	....	.....	No. 1 cotton duck.
Latigo strap	1	.....	90	87	1¼	....	.....	Harness leather.
Circular pieces, ¾ inch diameter	1	.....	.....	.....	.....	....	.....	Do.
Chapes	2	.....	8¾	4⅞	10	....	.....	Do.
Lacings	1	.....	18	18	¼	....	.....	Lace leather.
Metal frames	2	1	.....	.....	.....	....	.....	Gun metal.
Cargo cincha	1	.....	58	57	22	....	.....	No. 1 cotton duck.
Latigo straps	2	.....	88	85	2	....	.....	Harness leather.
Chapes	2	.....	8¾	4⅞	10	....	.....	Do.
Metal frames	2	1¼	.....	.....	.....	....	.....	Gun metal.
Belly cincha	1	.....	20	19	22½	....	.....	No. 1 cotton duck.
Chapes	2	.....	9½	4¾	5½	....	.....	Harness leather.
D-rings	2	.....	18	.....	.....	....	.....	½-inch iron, round.
Saddle pads	2	.....	46	23	25	....	.....	No. 1 cotton duck.
Tow	....	18	.....	.....	.....	....	.....	
Skirts ..... pairs	1	.....	17¼	17¼	25¾	....	.....	Harness leather.
Under covers ..... do	1	.....	10½	10½	25	....	.....	Do.
Facings on front	2	.....	41½	41½	3	....	.....	Do.
Facings on rear	2	.....	46	46	4	....	.....	Do.
Facings on top	2	.....	25¼	25	3	....	.....	Do.
Sockets	4	.....	6½	.....	6	....	.....	Collar leather.
Sockets, reënforce	4	.....	5¼	.....	4¼	....	.....	Do.
Lacings	4	.....	72	72	⅛	....	.....	Lace leather.

Bill of materials for one Hotchkiss packing outfit—Continued.

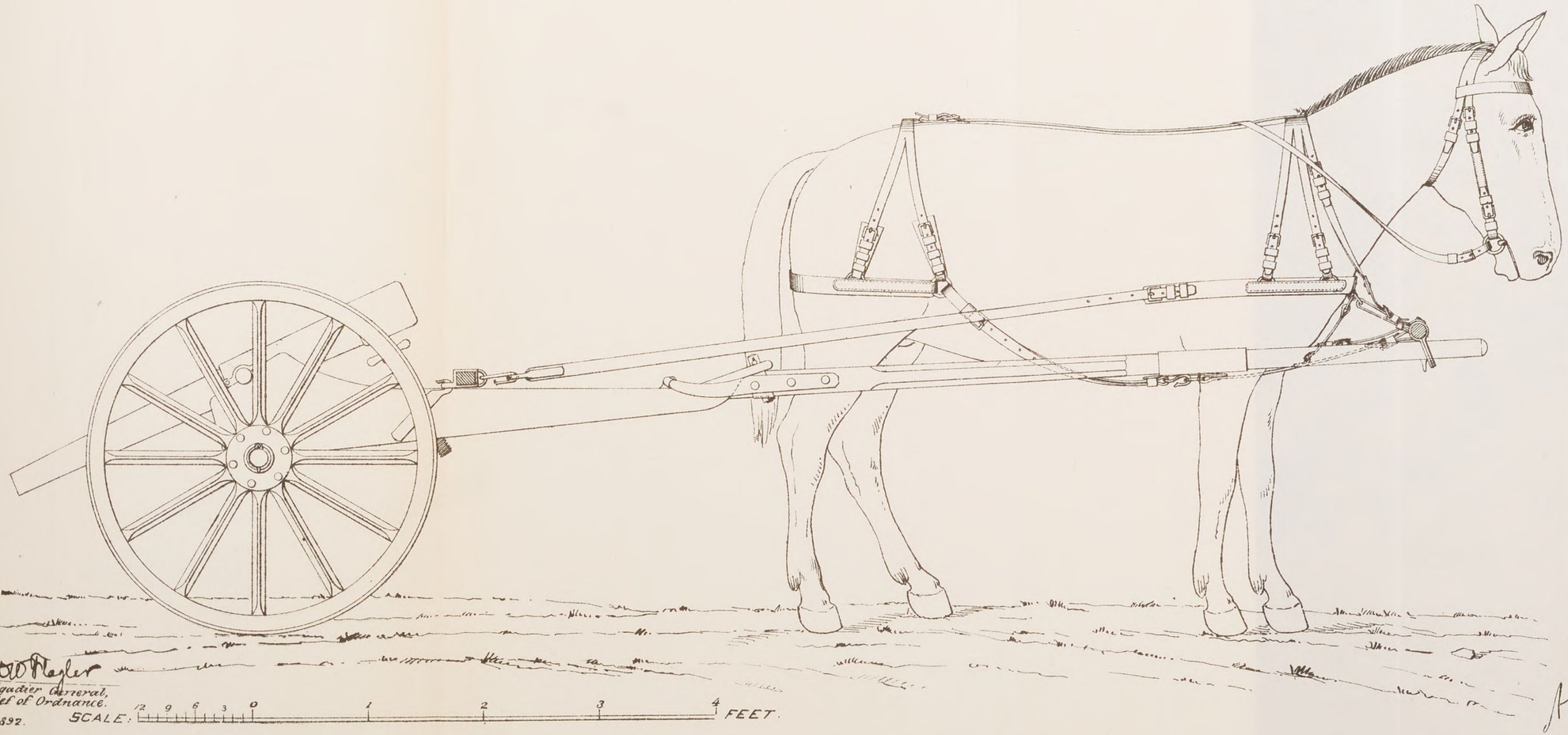
Name of parts.	Number.	Weight.	Length.		Width.	Buckles.		Material.
			Cut.	Finished.		Number.	Width.	
One pack saddle for ammunition—Continued.								
Saddle:		*Lbs.*	*In.*	*In.*	*In.*		*In.*	
Side pieces for crupper	2	.....	23	23	11½	....	.....	Collar leather.
Linings for crupper	2	.....	22	21½	12½	....	.....	Do.
Reënforce for crupper	2	.....	11½	11½	2	....	.....	Harness leather.
Docks for crupper	1	.....	10¾	10¾	7½	....	.....	Do.
Lacings	2	.....	72	72	¼	....	.....	Lace leather.
Lashing rope	1	.....	240	240	.....	....	.....	⅜-inch manila rope.
One set double harness.								
Bridle:								
Crown pieces	2	.....	23	23	1⅜	....	.....	Harness leather.
Cheeks	4	.....	27	17½	¾	4	¾	Do.
Throat latches	2	.....	21	17	⅝	2	⅝	Do.
Brow bands	2	.....	21	15½	¾	....	.....	Do.
Reins	4	.....	60	60	⅞	4	⅞	Do.
Bits	2	.....	.....	.....	.....	....	.....	Malleable iron.
Rein billets	4	.....	12	12	⅞	....	.....	Harness leather.
Breast collar:								
Bodies	2	.....	60	60	1⅞	4	1¼	Harness leather.
Lays	4	.....	10	10	1	....	.....	Do.
Chapes	4	.....	10	6	1¼	....	.....	Do.
Tugs	8	.....	10½	4	¾	8	¾	Do.
Shoulder pieces	2	.....	38	38	2¼	....	.....	Do.
Neck-piece chapes	4	.....	20½	17	¾	4	¾	Do.
Neck-piece billets	2	.....	12	12	1¼	....	.....	Do.
Collar straps	2	.....	16¼	14	¾	....	.....	Do.
Back straps	2	.....	40	40	1	....	.....	Do.
Traces	4	.....	66	66	1¼	....	.....	Do.
Trace clips	4	.....	8	.....	.....	....	.....	⅜-inch iron, round.
Breeching:								
Bodies	2	.....	38½	38½	1⅝	....	.....	Harness leather.
Lays	4	.....	13¼	10¼	1⅛	....	.....	Do.
Side straps	4	.....	77½	62	1	4	1	Do.
Hip straps	4	.....	24	21½	1½	....	.....	Do.
Tugs	8	.....	13	5½	¾	8	¾	Do.
Tug safes	8	.....	.....	.....	.....	....	.....	Do.
Back-strap tugs	2	.....	6¼	2⅞	1	2	1	Do.
Back-strap tug safes	2	.....	.....	.....	.....	....	.....	Do.
Hooks	4	.....	10	.....	.....	....	.....	¼-inch iron, round.
Martingale:								
Bodies	2	.....	43½	37¼	1½	2	1½	Harness leather.
Safes	2	.....	6½	6½	5	....	.....	Do
Chapes	2	.....	3½	2	¾	2	¾	Do.
D-rings, blued	2	.....	7	.....	.....	....	.....	3/16-inch iron, round.
Pole straps: Bodies	2	.....	31	28	1¼	2	1¼	Harness leather.
Harness sack:								
Body	1	.....	46	45	34½	....	.....	No. 8 cotton duck.
Sides	2	.....	17	16½	14¼	....	.....	Do.
Billets	2	.....	7	7	¾	....	.....	Collar leather.
Chapes	2	.....	3½	2	¾	2	¾	Do.
One cartridge pack.								
Bodies	2	.....	12	12	7	....	.....	Collar leather.
Connecting piece	1	.....	20	20	7	....	.....	Do.
Carrier-strap chape	1	.....	9	7	1	1	1	Do.
Carrier-strap billet	1	.....	11½	11½	1	....	.....	Do.
Cartridge loops	2	.....	16¾	16¾	1½	....	.....	Do.
Block cover	2	.....	13¼	13¼	1¾	....	.....	Do.
Block	2	.....	7	7	2¼	....	.....	1¾-inch thick poplar.
One neck yoke.								
Main part	1	.....	39	39	2	....	.....	2-inch thick hickory.
Brace	1	.....	12½	5½	3¾	....	.....	Harness leather.
Brace billet	1	.....	9½	9½	⅝	....	.....	Do.
Staples	2	.....	5	.....	.....	....	.....	¼-inch iron, round.
One pole.								
Main part	1	.....	76	76	3	....	.....	3-inch thick hickory.
Loop for attaching to carriage	1	.....	18	.....	1½	....	.....	¾-inch iron.
Pintle pin	1	.....	5½	5½	.....	....	.....	1¼-inch thick iron.

Bill of materials for one Hotchkiss packing outfit—Continued.

Name of parts.	Number.	Weight.	Length.		Width.	Buckles.		Material.
			Cut.	Finished.		Number.	Width.	
One pole—Continued.		*Lbs.*	*In.*	*In.*	*In.*		*In.*	
Key	1	.....	5½	.....	¾	....	.....	½-inch thick iron.
Iron chain	1	.....	18	.....	.....	....	.....	3/16-inch iron.
Staples	1	.....	3	.....	.....	....	.....	Do.
Stop for neck yoke	1	.....	8	.....	.....	....	.....	½-inch iron.
Iron sleeve for joint	2	.....	5	.....	4	....	.....	¼-inch thick iron.
Link for joining ends	1	.....	5	.....	2¼	....	.....	⅜-inch thick iron.
Rivets for joining link	2	.....	2½	.....	.....	....	.....	½-inch iron.
Sleeve for slipping	1	.....	9¼	.....	6	....	.....	⅜-inch thick iron.
Chape	1	.....	4½	2	⅝	1	⅝	Collar leather.
One splinter bar.								
Main part	1	.....	57	.....	1¾	....	.....	2¼-inch thick hickory.
Band and hook for attachment	2	.....	8	.....	1¼	....	.....	¾-inch thick iron.
Rivets	6	.....	1½	.....	.....	....	.....	⅜-inch iron, round.
Bands for carriage attachment	2	.....	6	.....	1	....	.....	½-inch thick iron.
Bands for trace attachment	4	.....	5	.....	½	....	.....	⅜-inch thick iron.
Do	4	.....	7	.....	.....	....	.....	⅜-inch iron, round.
Four ammunition boxes.								
Wood parts	8	.....	24½	.....	8½	....	.....	⅞-inch thick white pine.
Do	8	.....	24½	.....	7	....	.....	Do.
Do	8	.....	7½	.....	7¾	....	.....	Do.
Do	16	.....	7¼	.....	6¾	....	.....	Do.
Do	4	.....	7¼	.....	6¾	....	.....	1¾-inch thick white pine.
Handles	8	.....	9	.....	¾	....	.....	⅛-inch thick iron.
Cover fastenings	8	.....	12	.....	.....	....	.....	No. 8 wire.
Do	8	.....	11	.....	.....	....	.....	Do.
Springs	8	.....	2	.....	⅝	....	.....	No. 24 sheet brass.
Safety hinges	8	.....	12	.....	7/16	....	.....	No. 16 steel wire.

Showing the following changes:

1. dispensing with blinds
2. Strap put on front end of back-strap and connected with buckle in neck-yoke strap.
3. Martingale added, side straps detached from breast-strap and connected with martingale

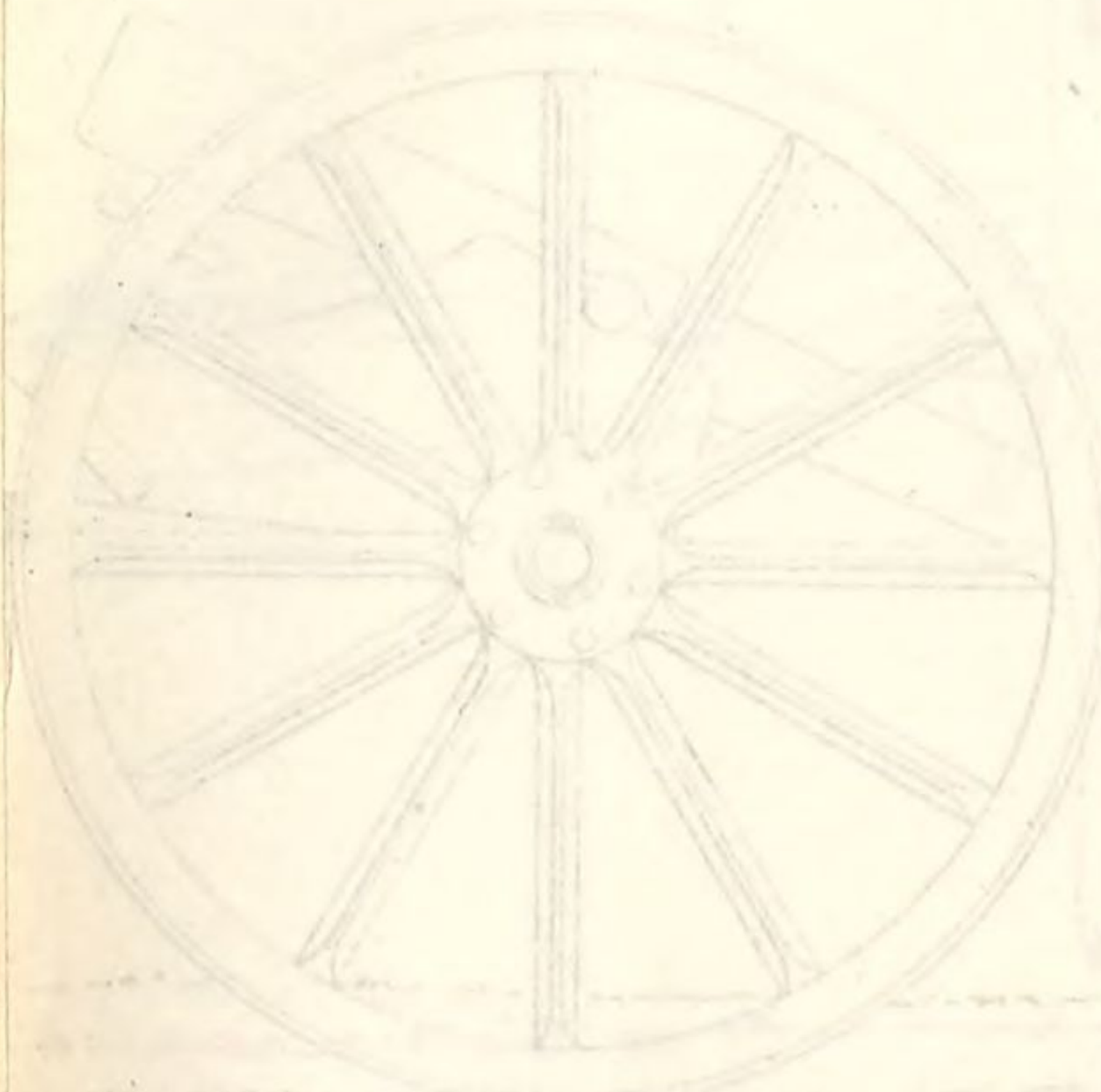


Approved:
O.D. Ordway
Brigadier General,
Chief of Ordnance.
June 16, 1892.

SCALE. 12 9 6 3 0 1 2 3 4 FEET.

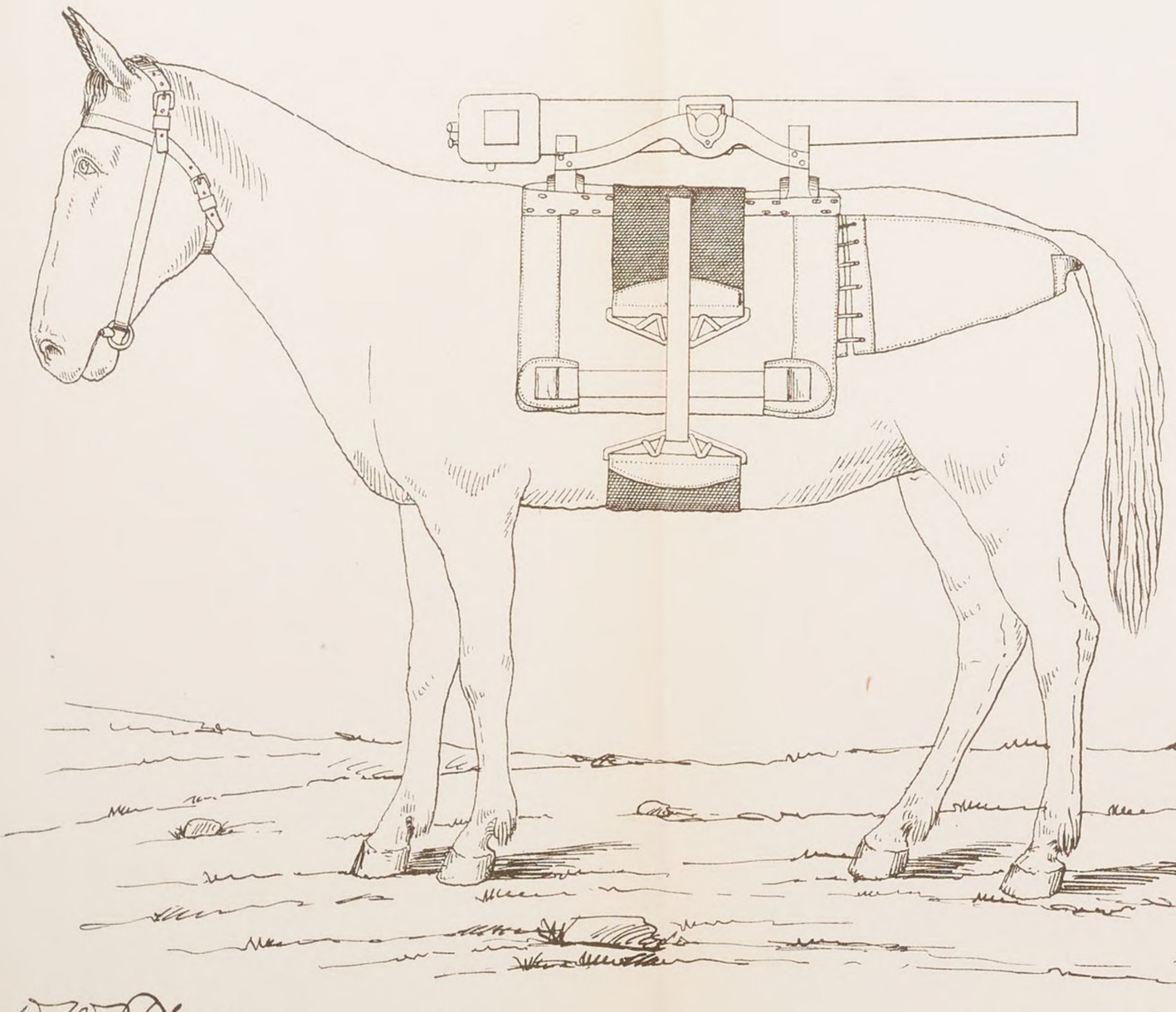
Rock Island Arsenal,
April 1892.
J. P. Duffield
Colonel of Ordnance, U.S.A.
Commanding.

Appendix 27, 1892.



— HOTCHKISS MOUNTAIN GUN PACK. —

Showing change in position of Gun in cradle, by raising front support ½ Inch, and rear support 2½ inches, and fastening sides with rivets instead of screws.



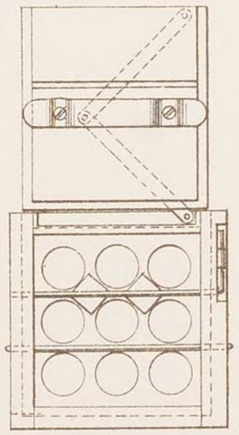
Rock Island Arsenal
June 7th 1892
A R Buffington
Colonel of Ordnance.
U S A
Comm.d'g.

Approved: *D W Flagler*
Brigadier General,
Chief of Ordnance.
June 16, 1892.

— HOTCHKISS MOUNTAIN GUN PACK. —

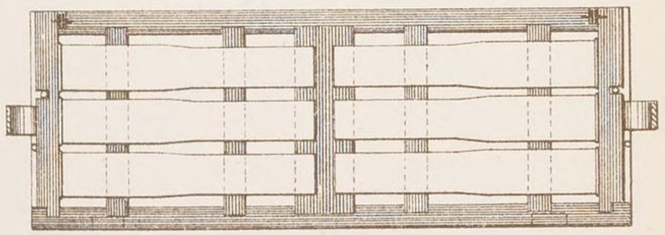
Ammunition Box.

End View of Box, with lid open.

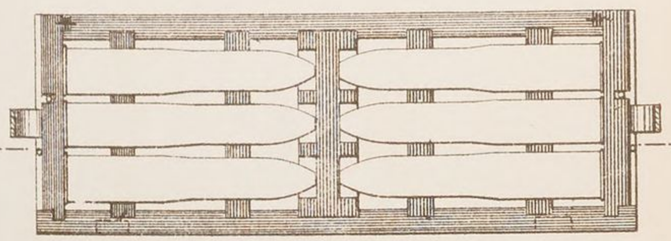


Side View.

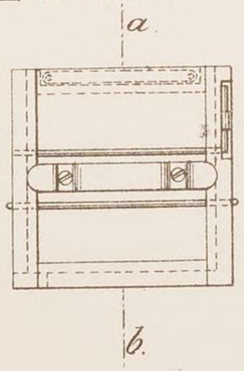
Vertical longitudinal section through box at line a.b. filled with canister.



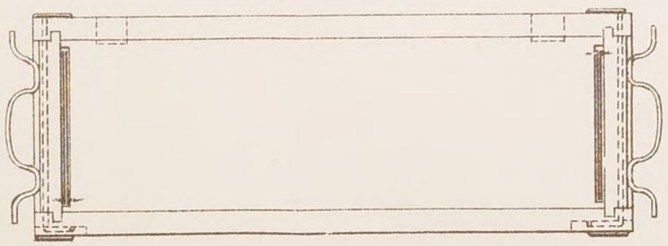
Vertical longitudinal section through box, at line a.b., filled with shell.



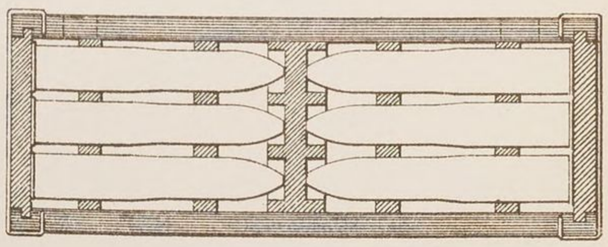
End View of Box.



Top View.



Horizontal section at line c.d.

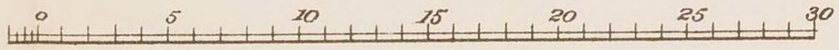


Approved: D.W. Flagler.
Brigadier General,
Chief of Ordnance.
Aug. 27, 1892.

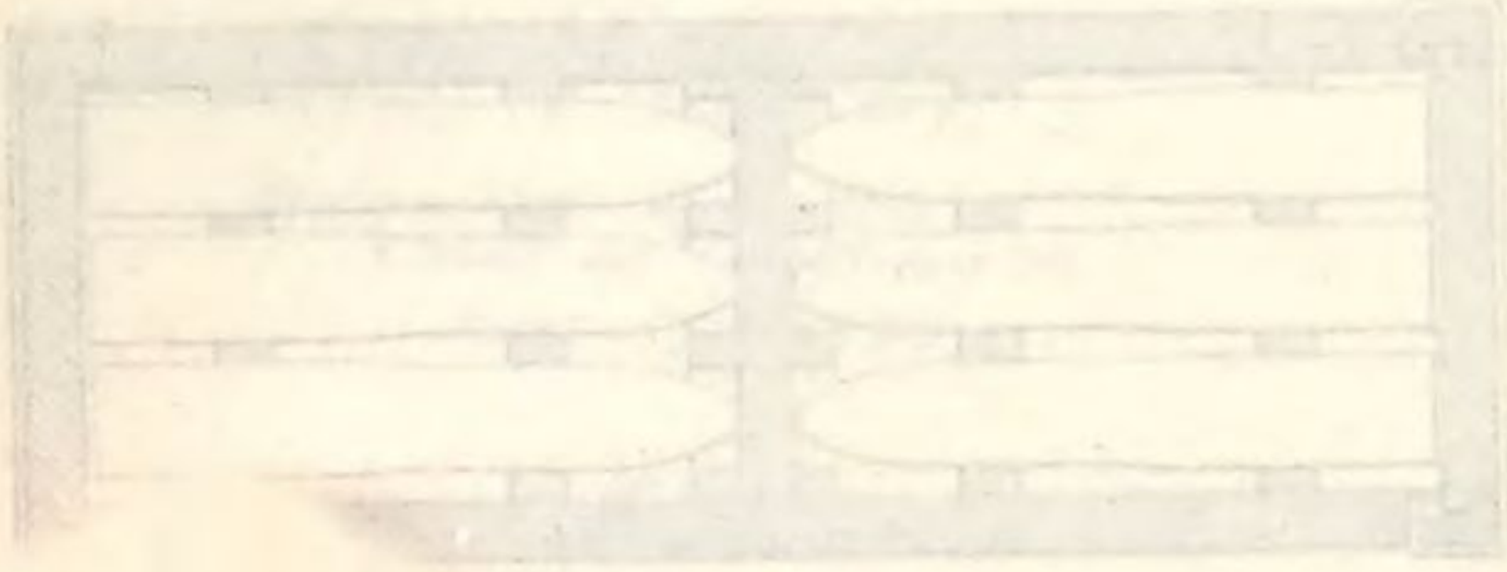
Rock Island Arsenal,
July. 9th 1892.

A.R. Buffington
Colonel of Ordnance, U.S.A.
Commanding.

Scale.

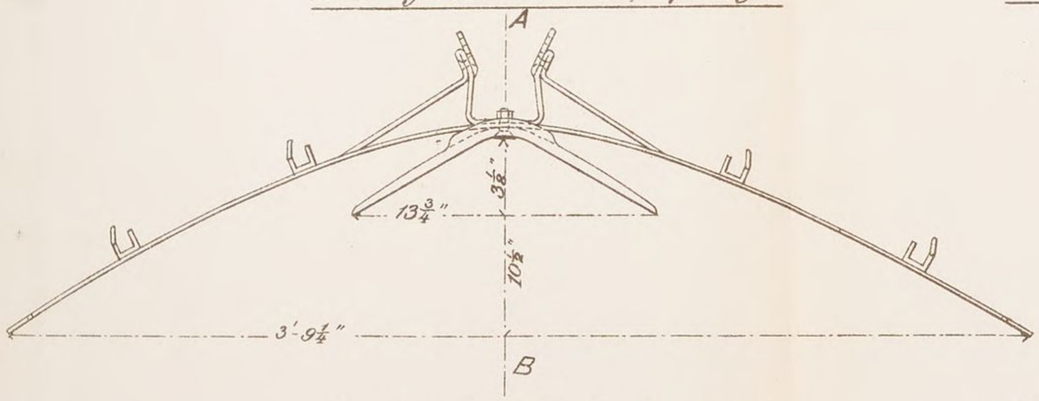


Inches.

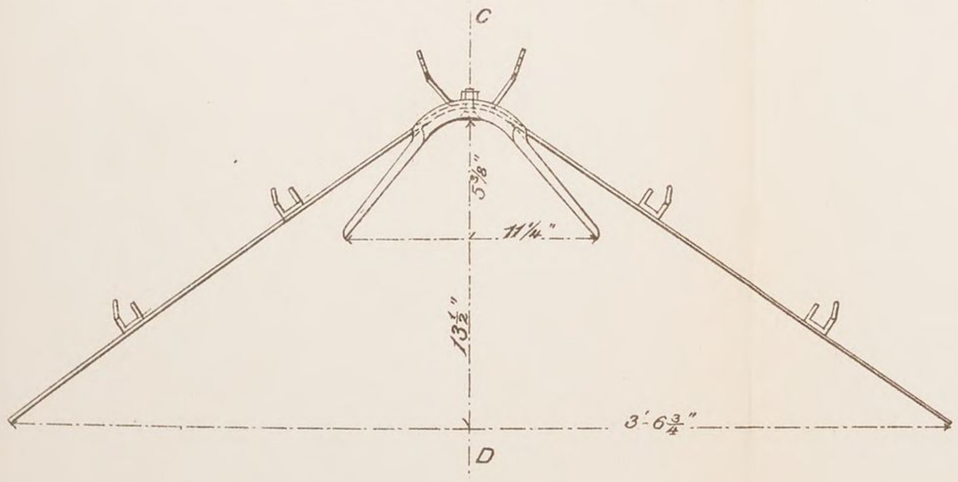


— HOTCHKISS MOUNTAIN GUN PACK. —

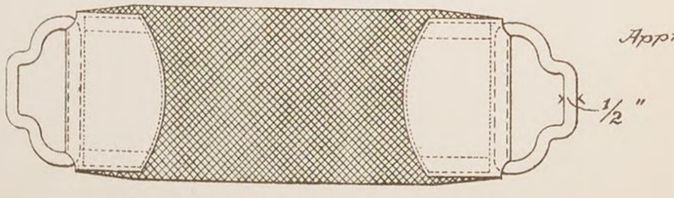
Rear yoke with steel springs.



Front yoke with steel springs.



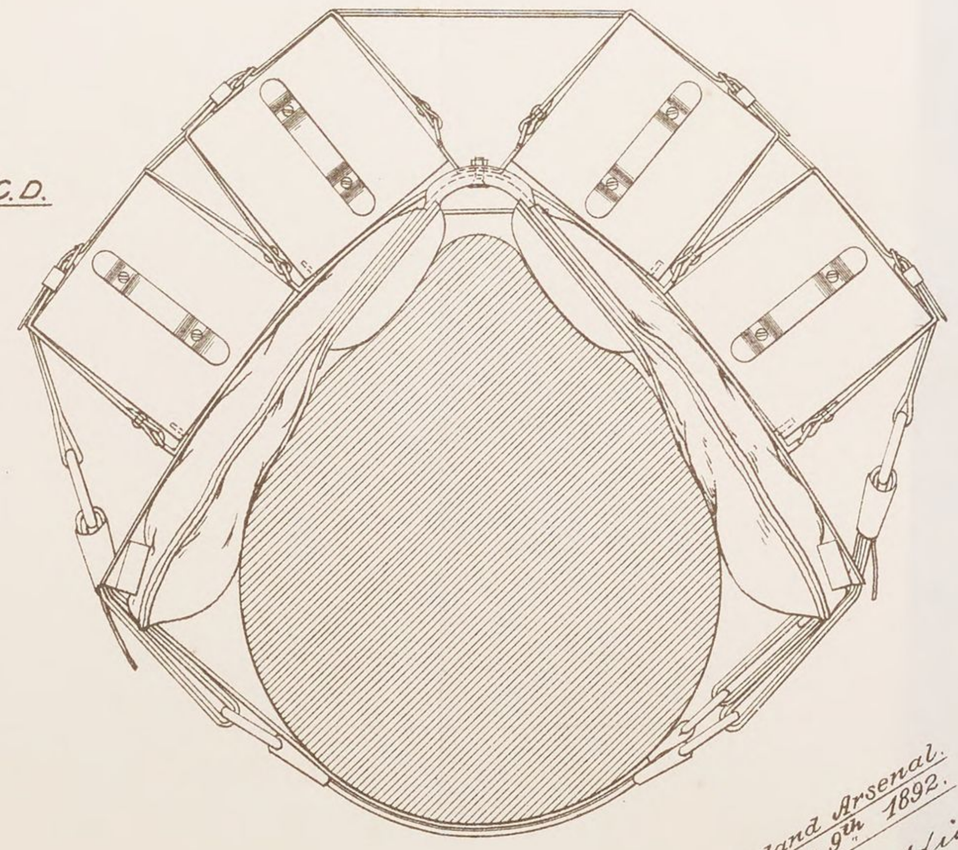
Belly cincha with "D" rings.



Section at A. B.

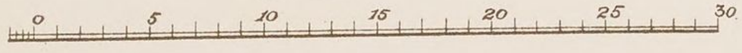
Section at C. D.

Front View of Pack.



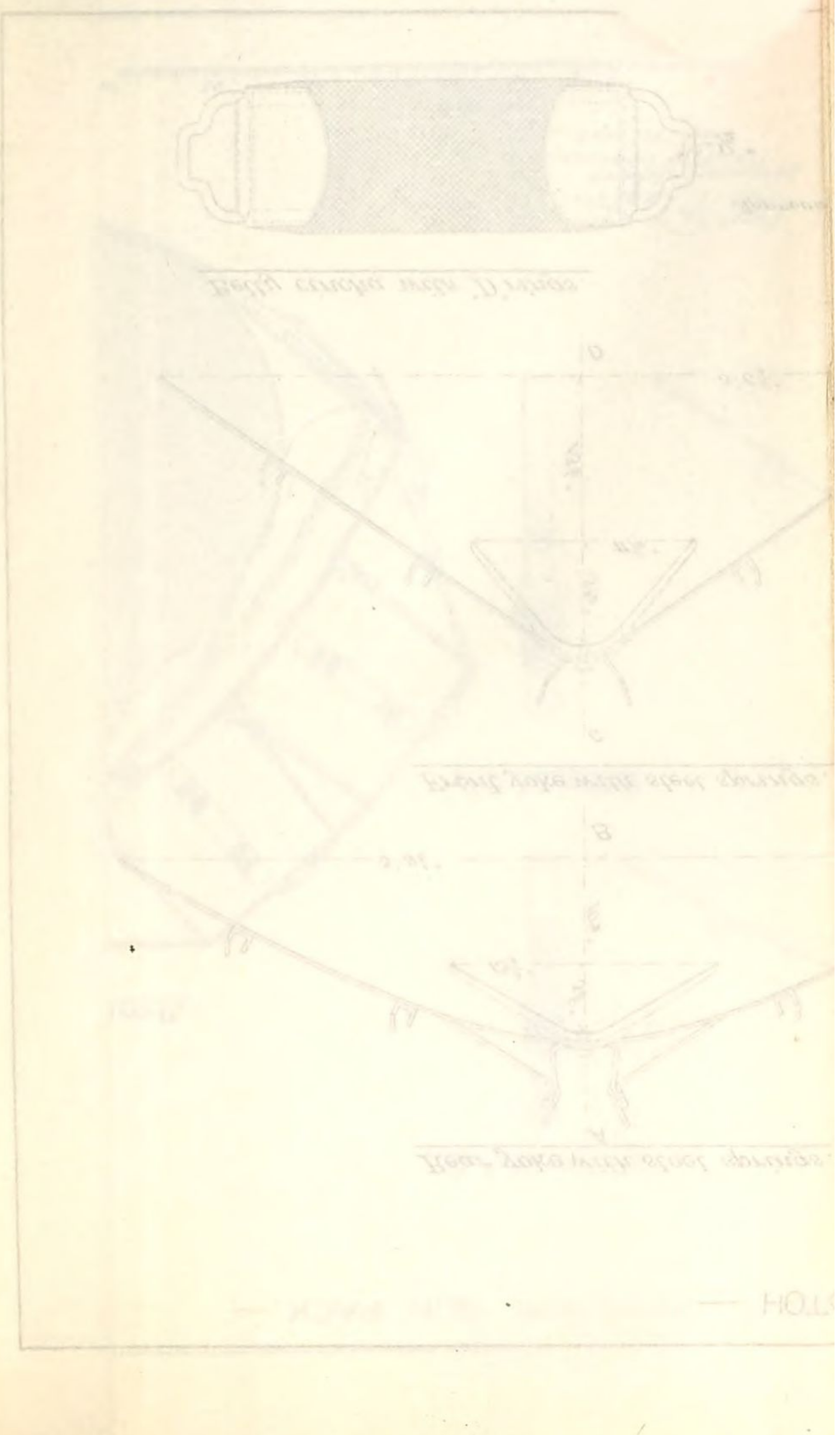
Approved: D W Flagler
Brigadier General,
Chief of Ordnance
Aug. 27. 1892.

Scale.



Inches.

Rock Island Arsenal,
July 9th 1892.
A. R. Buffington
Colonel of Ordnance, U.S.A.
Commanding.

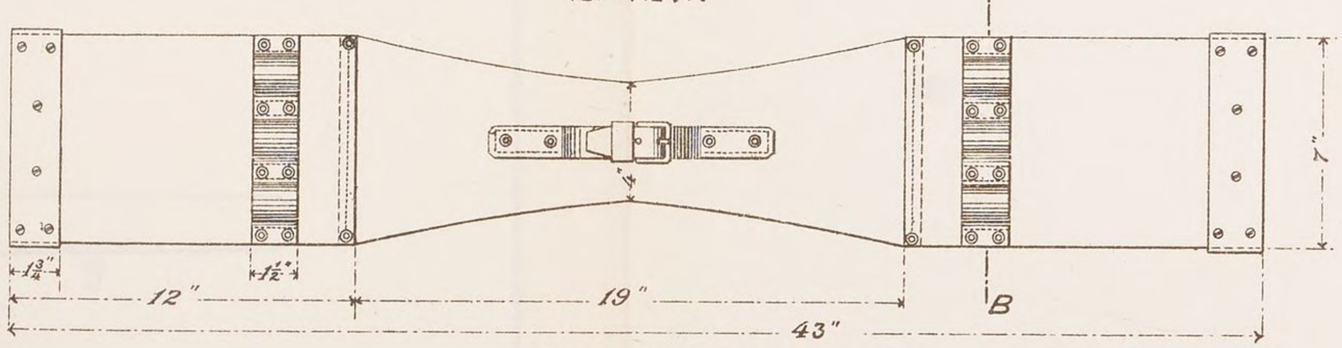


Ammunition Pack.

to accompany Hotchkiss Mountain-Gun Pack.

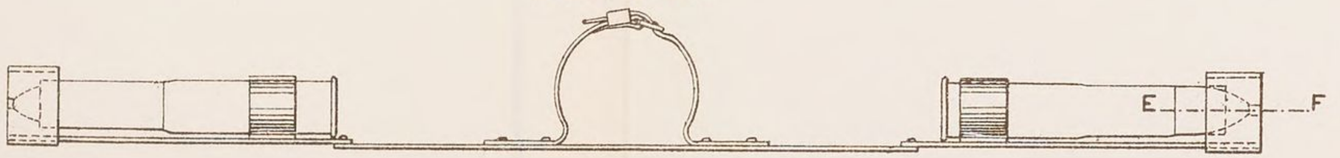
showing Ammunition Pack for six charges, to be carried with Gun.

TOP VIEW.

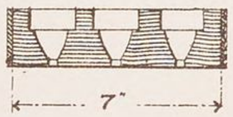


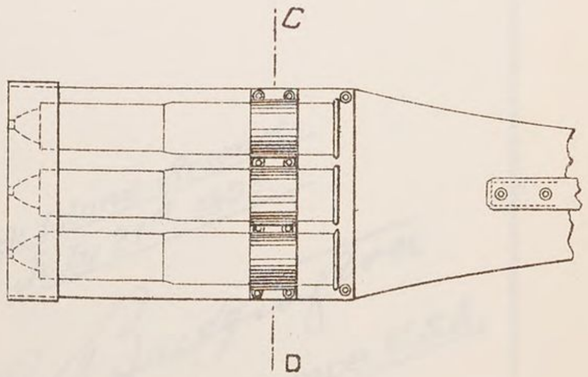
SECTION AT A.B.

SIDE VIEW.



SECTION AT E.F.





PART OF PACK,
WITH CARTRIDGES IN PLACE.

SECTION AT C.D.

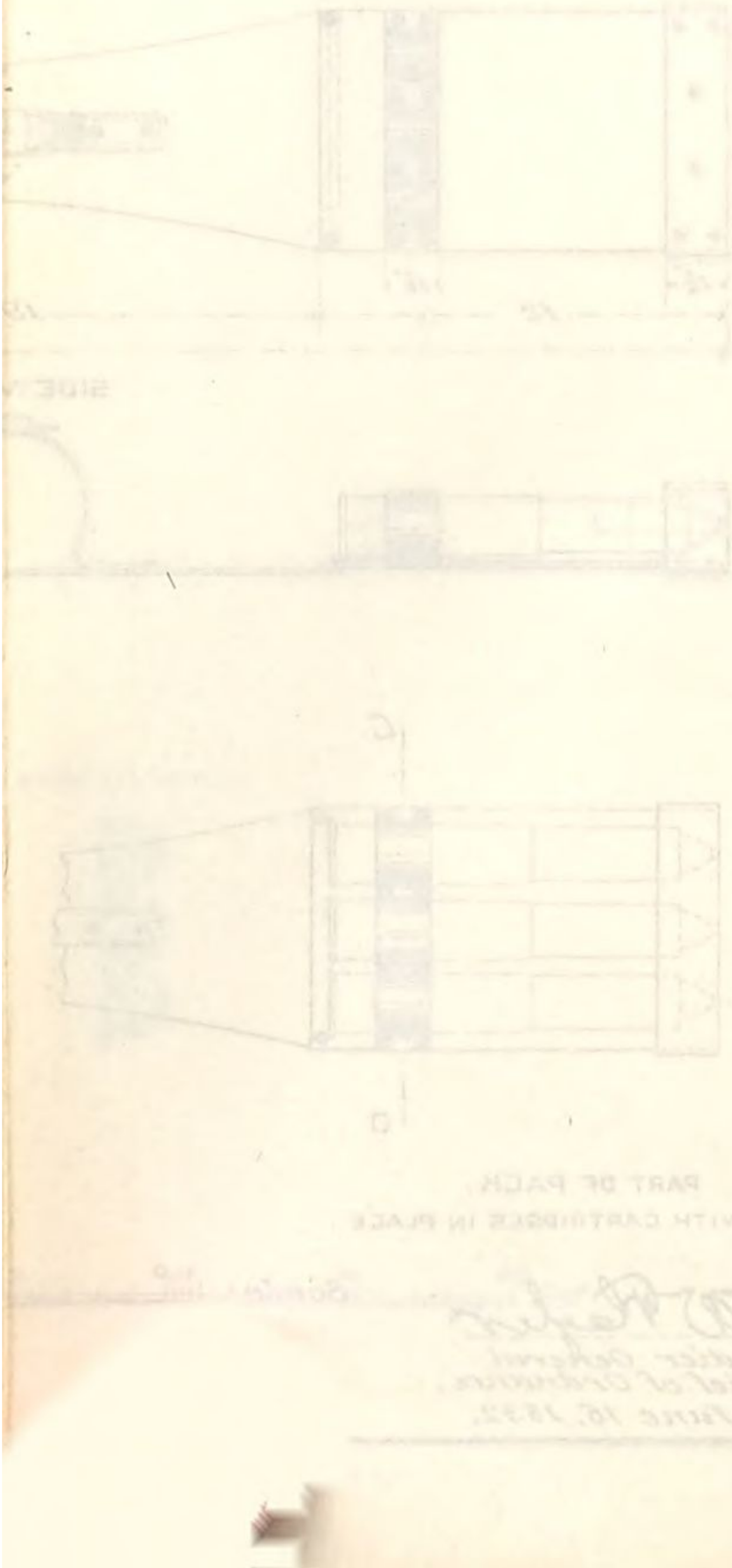
Approved:

D W Flagler
Brigadier General
Chief of Ordnance.
June 16, 1892.

Scale: 0 5 10 15 20 Ins.

Rock Island Arsenal,
April 1892.

A. P. Buffington
Colonel of Ordnance, U.S.A.
Commanding.

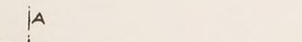


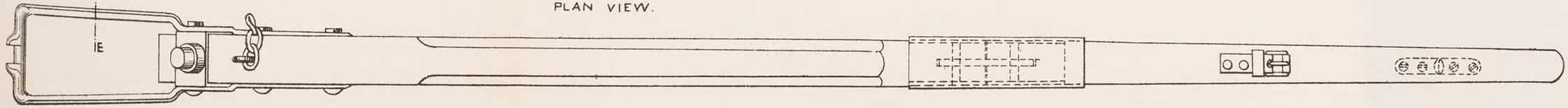
— POLE [FOLDING] FOR HOTCHKISS MOUNTAIN-GUN PACK. —

Showing folding pole with rear irons strengthened.

SIDE VIEW.

SECTION AT A. B.





PLAN VIEW.

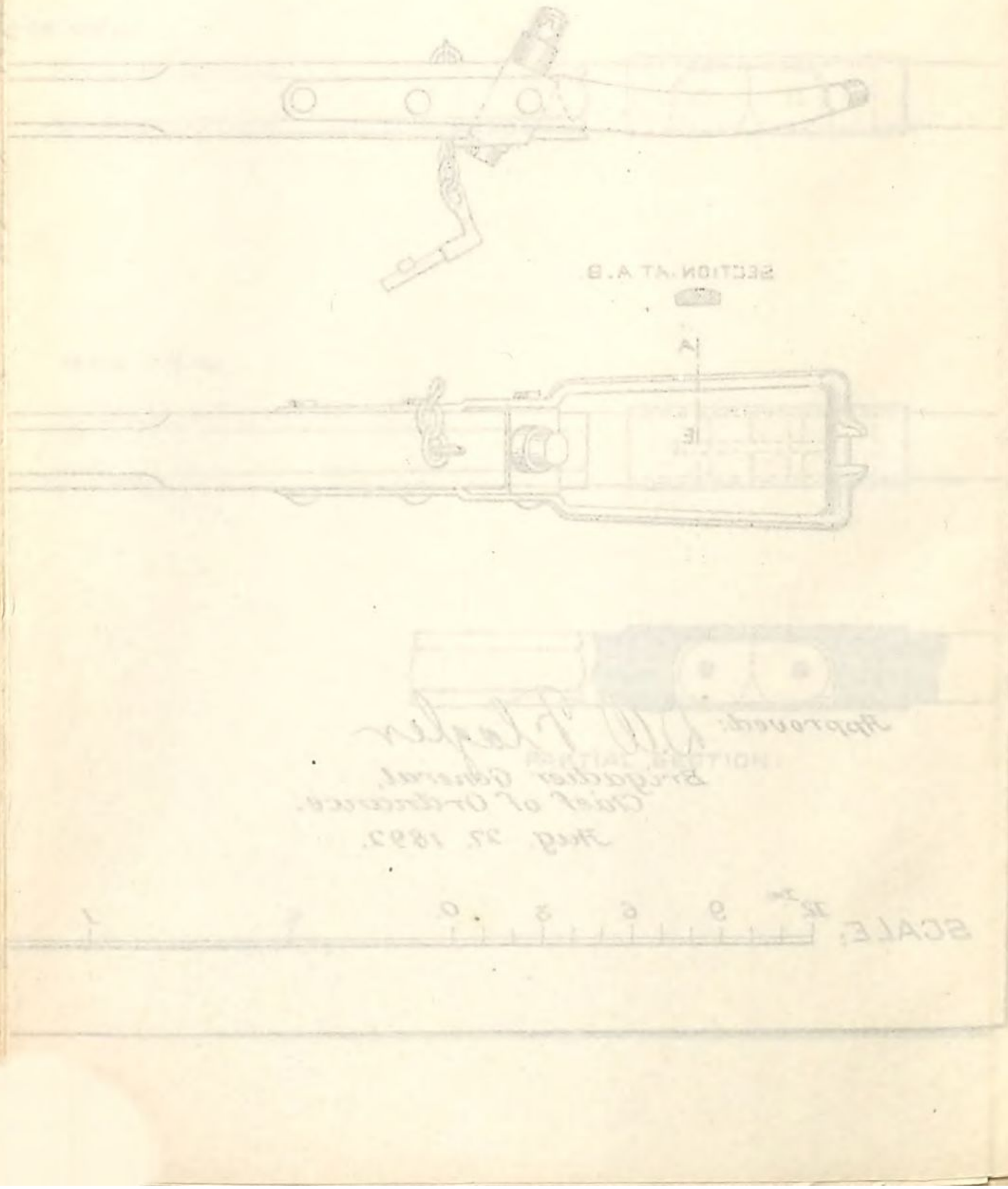
PARTIAL SECTION.

Approved: D. W. Flagler
Brigadier General,
Chief of Ordnance.
Aug. 27. 1892.

SCALE: 12 In. 9 6 3 0. 1. 2. Ft.

Rock Island Arsenal.
July 21st 1892.

A. R. Buffington
Colonel of Ordnance, U.S.A.
Commanding.



APPENDIX 28.

REPORT OF PRINCIPAL OPERATIONS AT THE WATERTOWN ARSENAL, MASSACHUSETTS, DURING THE FISCAL YEAR ENDING JUNE 30, 1892.

The principal work done at this arsenal during the year has been upon gun carriages for seacoast guns and the enlargement and improvement of the gun-carriage plant.

The need of a complete modern gun-carriage plant has been recognized by the War Department for some years. After a thorough study of the advantages and disadvantages of all the arsenals in this regard, Watertown Arsenal seemed, upon the whole, to be the most advantageously located, and it has been settled upon as the site of such an establishment.

In compliance with instructions from the Chief of Ordnance, the first steps toward the conversion of this arsenal into such an establishment were taken in April, 1891, when the work of adapting the west timber shed for use as an iron and brass foundry was commenced. This building is located near to and parallel to the machine shop. Its location was therefore favorable, both as regards present convenience and in respect to future plans. The second-story floor was removed from nearly the entire length of the building, giving ample overhead room for cranes, and a one-story extension of brick of a corresponding architecture was built along the south side. These alterations and additions give us a building admirably adapted to its purposes, with plenty of light and ventilation, and capable of extension to any desired extent. There have been erected in this building (located in the side extension) one 18-ton air or reverberatory furnace and two patent cupola furnaces of a melting capacity of 7 and 6 tons, respectively, a total melting capacity of between 25 and 30 tons.

The necessary core ovens for the largest castings probable have been built, and two swinging cranes of moderate capacity advantageously located for handling the large ladles and castings.

One end of the building is set apart as a brass foundry, and the five furnaces in it enable us to make all of our brass castings.

Thus, without any special appropriation, and at a slight expense, the Government has been put in possession of a reasonably well equipped iron and brass foundry. Within the year it has produced sound castings of iron of 18 tons weight net, and brass castings of nearly 4 tons weight. These were made from novel and complicated patterns, and we can reasonably claim that the foundry at its outset has proven a success. The possession of even a foundry of any capacity is a desideratum to the Department, as it enables it to experiment with and improve upon new types of gun-carriage castings, for which private founders would not provide the facilities except at great expense. Of course,

the foundry is not all that is required, but it enables us to tide over an emergency. Traveling cranes of a capacity of at least 30 tons are needed to handle expeditiously the output.

A new steam engine of 150 horse power has within the last year or two been purchased and centrally located in the large machine shop. By means of iron-wire rope, power is transmitted from this engine to the foundry and to the blacksmith shop. This method of transmission was adopted in consideration of minimum expense and loss of power by friction. It has well answered its purpose.

When the gun factory was first established at Watervliet Arsenal many, if not all, of our serviceable machines—planers, lathes, etc.—were sent there as the beginning of its plant. Those that remained here were of obsolete patterns and nearly unserviceable through wear. A special appropriation of $27,000 was obtained from Congress for the purchase of new machines, and the following were procured, after advertisement:

One 16-foot boring and turning mill.
One shaping machine, 26-inch stroke, to plane 8 feet.
Two engine lathes, 8 feet bed, 14 inches swing.
One engine lathe, 10 feet bed, 20 inches swing.
One engine lathe, 20 feet bed, 20 inches swing.
One engine lathe, 20 feet bed, 33 inches swing.
One engine lathe, 24 feet bed, 36 inches swing.
Two radial drilling machines, 72 inches, complete.
One screw machine, Niles No. 3.
One tool-grinder.
One center-bolt cutter, No. 3, with dies and taps.
One bolt and nut facing machine.
Two Stow flexible shafts, No. , with drill press.
Two Dallett's portable drills, No. 3, complete, together with the necessary shafting and belting.

These tools have been set up and have been doing satisfactory work for several months. They are, however, but a small part, and a very small part, of the machines needed to do expeditiously, cheaply, and well the work that even now is required of this arsenal. Every day we are called upon to extemporize some expedient whereby some new shape of iron or brass can be finished. The gun-carriage problem is a progressive one. The machines that will do the work of to-day are inadequate to the work of to-morrow. Yet we have not made a commencement on gun carriages that will depress. With the Army Gun Factory and the various private establishments turning out completed guns with great rapidity, it would seem to be a pressing necessity that this establishment should, at a very early day, be fully supplied with modern machines, tools, and appliances adequate to its requirements. The gun-carriage problem is a very great and a very difficult one, and I only speak of the parts of the problem we here are called upon to meet.

The principal work of the shops during the year has been upon the alteration of old gun carriages, to adapt them to present service conditions; the construction of a new type of 12-inch and 8-inch B. L. barbette gun carriages; the manufacture of cast-iron projectiles for the seacoast service, of a new pattern of sponges and rammers for the same, of sea and land targets, mortar beds, and, generally, repairs and improvements upon the gun carriages, beds, and appliances at the proving grounds at Sandy Hook and the forts upon the seacoast.

The alteration of fifteen front pintle barbette carriages was proceeded with, and eight of these have already been issued to the service. The remaining seven will be completed in a few weeks.

Also, twenty 10-inch front pintle carriages have been in process of

alteration for use with the 8-inch M. L. rifle. They are completed and ready for issue. Eleven more of these carriages are being similarly altered, and they, too, will be completed in a few weeks.

The 12-inch and the 8-inch B. L. barbette carriages mentioned are type carriages, after designs by Capt. William Crozier, Ordnance Department. Patterns had to be made for these, and, considering all the delays incident to the completion of new designs, satisfactory progress has been made towards this end. All of the 8-inch carriage parts, except some minor ones of cast and forged steel, have been made at this arsenal. This carriage will be ready for issue and test early in the fall, and if, as is confidently expected, it fulfills its requirements these carriages can be expeditiously and cheaply reproduced to any extent.

Some of the larger parts of the 12-inch carriage, of this same general design, are of cast steel and are being made under contract with the Midvale Steel Company. We anticipate taking up this carriage upon the completion of the 8-inch carriage and to complete it, possibly, by early spring. Satisfactory results are also confidently expected in the test of this carriage, so the barbette-carriage question may be considered as practically solved. Of course, minor alterations and improvements will be adopted as experience may demand or suggest. One of the most difficult and delicate questions we have had before us has been the production of Belleville springs for the 12-inch B. L. mortar spring-return carriages. Some 500 of these springs are required for each carriage, and the carriage is incomplete without this or some other form of spring strong enough to return the mortar, after firing, to its normal position. Repeated efforts were made by the Department, through its agents abroad, to learn the composition of the metal and the processes of tempering these springs. No private factory in this country would undertake to reproduce them. The Department was forced to make the effort in its own shops, and, after an exhaustive series of experiments extending over the year, we are now turning out these springs for the service. A complete plant for punching out and tempering the springs has been placed in one end of the blacksmith shop and is accomplishing satisfactory work. The furnace is heated by a forced spray of crude petroleum and air mixed, and is large enough to accommodate, at one time, 9 springs of 9½-inch diameter each. The furnace is cleanly, easy of manipulation, uniform in its heating effect upon all of the springs, and economical. The heat acts by radiation from the top and sides of the furnace and by conduction from the bed upon which the springs lie. Among the most important of the experimental work under way during the year may be mentioned a shop comparator and also an apparatus for overstraining steel tubes.

The purpose of the shop comparator is to furnish the means for laying off distances from zero to 70 inches accurate to within .0005 of an inch, both for exterior and interior measurements. The bed is complete, as are the minor parts. The bar has been sent to the Coast Survey Office at Washington for graduation and comparison. When the bar is returned the comparator, complete, will be sent to the gun factory for use in the shops. Another one will be subsequently made, to be used here.

The apparatus for overstraining steel tubes provides for all of the simple strains and combination of strains to which a tube (as, for example, a section of an 8-inch steel gun tube) may be subjected. Progress upon this work has been slow, as the time necessary to its perfection has been broken in upon by more urgent work. However, it now approaches completion. The successful consummation of this series

of experiments will verify or refute many formulæ now in use in gun construction.

A series of copper compression experiments, designed by Lieut. B. W. Dunn, Ordnance Department, assistant at this arsenal, have also been prosecuted by your authority. They consist in the compression of copper cylinders or gauges by the expansive effort of the powder gases and translating these into pressures by means of a table, which shows the compressions and the static pressures necessary to produce them. The experiments so far conducted give promise of valuable results, and they will be prosecuted until definite conclusions are reached. Lieut. Dunn has also devised a chronograph for measuring very short intervals of time, which has not yet been tested, but it promises to be successful. Owing to the failure of the Department to receive any bids for the manufacture of the 10-inch Woodbridge wire-wound steel B. L. gun, its manufacture had to be undertaken in some one of the Department's arsenals, and it fell upon us to do it. This class of work is foreign to the purpose of this establishment, and suitable tools and appliances were always difficult, and sometimes impossible, to procure. The work, however, has steadily gone on and the gun is about finished, as far as our part of it is concerned. The rifling and the breech-fitting will be done at the Army Gun Factory.

J. W. REILLY,
Major, Ord. Dept., Commanding.

APPENDIX 29.

REPORT OF PRINCIPAL OPERATIONS AT THE PROVING GROUND.

(6 plates.)

SANDY HOOK PROVING GROUND,
September 15, 1892.

SIR: I have the honor to submit the following report of the principal operations of this post during the fiscal year ended June 30, 1892:

During the year experimental firings have been conducted daily whenever the weather and other circumstances would permit. The object of the firings and the extent and character of the work done at the proof batteries can be ascertained by an inspection of the following tables:

TABLE I.—*Showing firings made with seacoast guns at Sandy Hook proving ground during fiscal year ending June 30, 1892.*

Object of firing.	Breech-loading rifled mortars.					Breech-loading rifles.					M. L. rifles.			
		Cast-iron, steel-hooped.				Steel.				Cast-iron.				
	Steel, W. A., 12-inch, No. 1.	S. B. I. W., 12-inch, No. 1.	B. I. F., 12-inch, No. 1.	B. I. F., 12-inch, No. 2.	B. I. F., 12-inch, No. 3.	W. A., 12-inch, No. 1.	W. A., 10-inch, No. 1.	W. A., 8-inch, No. 1.	W. A., 8-inch, No. 4.	Steel tube, S. B. I. W., 12-inch.	Wire-wound, W. A., 10-inch, No. 1.	Chambered, W. P. F., 11-inch, No. 2.	Canét, S. B. I. W., 8-inch, No. 1.	Ames, wrought-iron, 7-inch, No. 2.
Accuracy	....	....	....	....	....	....	....	3	....	13	24	....	....	....
Endurance	....	....	....	....	....	....	....	....	....	....	72	....	....	....
Exhibition before Secretary of War	....	....	....	1	....	1	1	....	....	....	....	....	....	....
Experiments with high explosives	....	....	....	....	....	....	....	....	....	....	....	10	....	9
Experiments with deck-plate targets	....	....	....	7	....	....	....	....	....	....	....	....	....	....
Proof of—														
Powder	5	....	....	20	18	32	32	16	....	....	17	....	6	....
Range	....	....	....	3	....	....	....	....	....	....	8	....	....	....
Rapidity	....	....	....	....	....	....	....	....	....	8	10	....	....	....
Smoothness in flight of projectile	....	....	....	....	....	2	....	....	....	....	....	....	....	....
Test of—														
Banding of projectiles	....	....	....	....	....	....	....	15	....	....	....	....	....	....
Berdan fuse	....	....	....	....	....	....	....	....	....	....	....	...	4	....
Merriam fuse	....	....	....	4	2	....	....	....	....	....	....	....	....	....
Canét carriage	....	....	7	....	....	....	....	....	....	....	....	....	....	....
Easton and Anderson carriage	....	33	....	....	....	....	....	....	....	....	....	....	....	....
Free-recoil carriage	....	....	....	....	....	....	....	4	....	....	....	....	....	....
Pneumatic disappearing carriage	....	....	....	....	....	....	32	....	....	....	....	....	....	....
11¼-inch armor plate	....	....	....	....	....	....	3	....	....	....	....	....	....	....
French smokeless powder	....	....	....	....	....	....	4	....	....	....	....	....	....	....
German smokeless powder	....	....	....	....	....	....	1	14	....	....	....	....	....	....
Schaphaus-Houghton smokeless powder	....	....	....	....	....	....	....	3	....	....	....	....	....	....
Gun	17	....	7	5	6	5	....	....	7	....	....	....	....	....
Frankford Arsenal sight	....	....	....	....	....	....	....	22	....	....	....	....	....	....
Velocimeter, Siebert	....	....	....	....	....	....	....	7	....	....	....	....	....	....
To determine drift of projectile	....	....	....	....	....	....	17	....	....	....	....	....	....	....
To verify pressures	....	....	....	....	....	1	....	....	....	....	....	....	....	....
Total rounds	22	33	14	40	26	41	90	84	7	21	131	10	10	9

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TABLE II.—*Showing firings made with siege and field guns, howitzers, and mortars at Sandy Hook proving ground during fiscal year ended June 30, 1892.*

Object of firing.	Breech-loading rifles and howitzer (steel).									B. L. mortar, steel, W. A., 3.6-inch, No. 1.	M. L. rifle, wrought-iron, P. I. Co., 3-inch, No. 666.
	W. A., 1891, 3.2-inch, No. 1.	W.A., 3.2-inch, No. 18.	W.A., 3.2-inch, No. 26.	W.A., 3.2-inch, No. 32.	W.A., 3.6-inch, No. 1.	Hotchkiss mountain, 3-inch, No. 168.	Driggs-Schroeder, 6-pounder, No. 1.	Watertown Arsenal, 5-inch, siege, No. 1.	Watertown Arsenal, 7-inch howitzer, No. 1.		
Accuracy	.....	.....	10	.....	56	86	.....	.....	.....	.....	.....
Coefficient of reduction in ballistic formula	.....	.....	.....	.....	20	.....	.....	.....	.....	.....	.....
Endurance	.....	.....	.....	.....	258	320	.....	.....	.....	.....	.....
Exhibition before the Chief of Ordnance	.....	2	4	.....	.....	.....	.....	.....	.....	1	.....
Proof of powder	.....	32	49	30	241	32	7	.....	.....	.....	152
Range	.....	.....	.....	.....	.....	6	.....	.....	.....	31	.....
Rapidity	.....	.....	.....	.....	30	20	.....	.....	.....	.....	.....
Test of—											
Armstrong fuse	.....	.....	.....	.....	.....	6	.....	.....	.....	.....	.....
Frankford Arsenal combination fuse	.....	12	54	8	.....	.....	.....	.....	.....	.....	.....
Frankford Arsenal fuse with lead time train	.....	29	.....	.....	.....	.....	.....	.....	.....	.....	.....
McIntyre fuse	.....	.....	1	.....	.....	.....	.....	.....	.....	.....	.....
Merriam fuse	.....	.....	.....	.....	60	.....	.....	.....	.....	2	.....
Axial vent	.....	10	.....	.....	.....	.....	.....	.....	.....	.....	.....
Bode quadrant	.....	.....	.....	.....	82	.....	.....	.....	.....	.....	.....
Equipments for mortar	.....	.....	.....	.....	.....	.....	.....	.....	.....	79	.....
Electric-welded shrapnel	.....	49	131	19	.....	.....	.....	.....	.....	.....	.....
Frankford Arsenal shrapnel	.....	6	.....	14	.....	.....	.....	.....	.....	.....	.....
Hotchkiss shrapnel	.....	.....	118	.....	.....	.....	.....	.....	.....	.....	.....
Gerdom breech mechanism	85	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Seabury breech mechanism	.....	.....	.....	.....	.....	.....	.....	17	.....	.....	.....
Gravity chronograph	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....
French smokeless powder	.....	23	.....	2	.....	.....	.....	.....	.....	.....	.....
Schaphaus-Houghton smokeless powder	.....	2	.....	.....	.....	.....	.....	.....	.....	.....	.....
Powder put up in waterproof cases	.....	12	24	.....	.....	.....	.....	.....	.....	.....	.....
Projectiles	.....	.....	.....	.....	37	.....	11	.....	.....	.....	.....
Rafferty's friction recoil brake	.....	.....	2	.....	.....	.....	.....	.....	.....	.....	.....
Sawyer canister	.....	.....	4	.....	.....	.....	.....	.....	.....	.....	.....
Time of flight of shell	.....	.....	.....	.....	.....	1	.....	.....	.....	.....	.....
To determine—											
Jump of gun	.....	.....	.....	.....	15	.....	.....	.....	.....	.....	.....
Residue of silk cartridge bag to that of serge	.....	.....	.....	.....	50	.....	.....	.....	.....	.....	.....
Effect on crack in powder chamber	.....	.....	.....	.....	112	.....	.....	.....	.....	.....	.....
Effect of position of band on the accuracy of fire	.....	.....	.....	.....	6	.....	.....	.....	.....	.....	.....
Velocity of projectile	.....	.....	.....	.....	.....	.....	11	.....	.....	.....	.....
Test of carriage	.....	.....	.....	54	.....	.....	.....	99	21	.....	.....
Total number of rounds	85	177	399	127	967	471	29	116	21	113	152

IMPROVEMENTS.

The demands made upon the resources of the proving ground both for experimental and proof purposes are constantly increasing, and during the fiscal year considerable progress has been made in erecting buildings and procuring and establishing the plant and other appliances required to meet these demands.

The principal buildings erected during the year are an office building, barracks for the enlisted men, a magazine for the storage of high explosives, and a substantial shed in which to load shells with powder or high explosives, and for other purposes.

Office building.

The office building is a framed wooden structure, 52 feet 10 inches on the north and south elevations and 44 feet 6 inches on the east and west elevations. It is convenient and on the whole admirably adapted for proving-ground purposes, having on the first floor a spacious instrument room, rooms for clerks and draftsman, and offices for the proof and assistant proof officers; and on the second floor a battery and battery storeroom, photograph room, office of the Ordnance Board, and three sleeping rooms for clerks and draftsman. On account of the liability to injury due to shock of discharge of heavy guns no plaster is used, but all walls and ceilings are ceiled with North Carolina pine, tongued, grooved, and beaded, the floors being laid with the same material. The building is made substantially fireproof by means of an automatic-sprinkler system by which any room can be flooded with water in case of fire. The instrument room is provided with four Boulengé chronographs, modified by Bregér, two of which were purchased during the present fiscal year, a drop chronograph, a Seibert velocimeter, a Western Union switchboard with sixty straps and fifty disks, detector, tangent and universal galvanometers, a mercurial densimeter, weighing scales, star gauge, and other instruments, and a complete set of gauges for determining the pressure of powder in guns. The four chronographs are so connected with the runways at the firing batteries that, using two instruments for each gun, simultaneous velocities may be obtained from two guns at the main firing battery, or from one gun at the main battery and one gun at the siege battery, as may be desired. For velocity, signal, telephone, anemometers, and other purposes fifty-two wires enter the office building. Those from the main battery are of No. 10 phosphor-bronze wire. They are strung on poles, and in order to avoid obstructions a rather circuitous route is necessary to reach the office. The runways of the siege battery are connected with the switch board by a standard cable of twenty-two wires, No. 14, B. and S. gauge, with tubular terminals of twenty-five wires each, the cable being laid underground. This method was tried as an experiment. It has worked well and has so many advantages over wire strung overhead on poles that it is believed that it would be in the interest of economy and efficiency to connect the runways of the main battery with the office by a similar cable.

The accompanying plan of the proving ground shows the office located at the point B. Its distance from the main battery is such that in firings for velocity the chronograph rods are released before the vibrations produced by the shock of discharge can reach the building, a very essential condition in order that reliable results may be obtained. This office building was designed by the architect R. M. Hunt, of New York, under the direction of my predecessor, Capt. Charles Shaler. The specifications which governed its construction are attached hereto, together with drawings showing front and rear elevations and plan of first floor. The building is heated throughout by water, using indirect radiation on the first and direct radiation on the second floor.

Barracks for enlisted men.

This building is a substantial frame structure, rectangular in shape, measuring 52 by 134 feet, the front being broken by a tower and veranda. It has messing capacity for 50 and sleeping accommodation for 80 men. On the first floor are conveniently located the kitchen, dining room,

wash and bath room, reading room, dispensary, and other offices, together with quarters for three married men, which are completely isolated from the main portion of this floor. The second floor is divided into six square rooms. Water is supplied by means of a tank of 4,000 gallons capacity placed in the attic; this tank is filled from a well by means of a Rider hot-air, pumping engine. This building was designed and the specifications were prepared by Lieut. C. B. Wheeler, Ordnance Department, under the direction of Capt. Shaler. Both office and barracks were built in a satisfactory manner by the contractor, Mr. John Larkins, within the time specified by the contract.

Gantry crane and runway.

The most important work accomplished during the year in connection with improving the facilities for conducting experiments at the proving ground is the erection at the main battery of the gantry crane with its runway. This gantry crane, so named from the form of its mounting, consists of a substantial steel framework supporting a heavy steel girder bridge, on which travels the trolley from which the weight to be moved is suspended by means of a stout hook and hoisting chains. The crane rests on four truck wheels and is carried on a platform car or transfer table, which runs along the front of the battery on a double-railed track sunk below the level of the platforms to a depth equal to the height of the car. Each platform is supplied with double-railed "run offs," on which the gantry can be transferred and placed over any gun or carriage of the battery, as may be desired. A run off is placed at the west end of the battery, through which passes the main railroad track leading to the wharf. A gun having been placed on a car can be taken to this run off, where it is picked up by the gantry and mounted on its carriage, accomplishing in a few hours' work what under former conditions would have required as many days. Carriages, face plates for platforms, and other heavy pieces are handled in the same way and with equal facility. The crane was built by the Shaw Electric Crane Company, of Muskegon, Mich. Its principal details as required by the specifications are as follows: Its maximum lifting capacity is 80 gross tons. Its span is 17 feet from center to center of tracks of car and run offs. The maximum hoist is 15 feet from the ground to the bottom of the hook when the latter is in its highest position.

The trolley has a travel of 6 feet on either side of the center and is provided with stops to prevent overrunning in either direction.

The steel used in the construction of the girders and entire framing of the gantry has an ultimate strength of 55,000 to 60,000 pounds with an elongation of 20 per cent, and is so proportioned that the maximum stress in tension or compression will not exceed 8,000 pounds per square inch when the gantry is sustaining its maximum load of 80 tons. The trolley is placed on top of the girders forming the bridge, so that the bottom block rises between them, by which means the greatest obtainable height of hoist is secured. The trolley rails are located directly over the ribs of the girders and have a flat bearing on the rails of $2\frac{1}{2}$ inches in width.

All movements of the crane are operated from platforms near the ground; all handles and levers being so grouped as to be readily accessible and convenient for operation.

The trolley and main truck wheels have chilled faces, each set being ground true and to same size. All shafts are of open-hearth steel, those

over 4 inches diameter being of open-hearth steel forgings. The truck-wheel bearings and bearings of main shaft and first pinion shaft are roller bushed.

The hoisting chains are in sixteen parts of $1\frac{3}{16}$ inches special chain iron, having a tensile strength of not less than 52,000 pounds per square inch, an elongation of 15 per cent, and contraction of area of 20 per cent. The chain winds over two pocketed chain wheels, one on either side of the center, thus giving a vertical hoist and symmetrical loading on either girder. The free ends of the chain drop into a chain box located between the legs and near the bottom of the gantry. The chain sheaves are 24 inches in diameter, with chain grooves of such depth that the vertical links bear on the bottom of the grooves and the horizontal links on the plates, and so arranged that the pull of all parts of the chain is at all times vertical.

The main hoisting gear is of gun iron, and pinion meshing therein of steel. All other gears are of tough strong cast iron, and all pinions of less than 20 teeth are of steel. The hoisting mechanism is provided with simple and powerful brakes, which automatically sustain the load at any point of the hoist. There are two ratios of hoisting gearing—one for the maximum load, the other for loads of about 15 tons. The hook is double, and has a clear opening of 8 inches at the throat. It is supported by antifriction rollers, so as to be capable of revolving freely about a vertical axis when sustaining its maximum load. The hoisting gearing is so arranged as to be operated from either or both sides of the gantry, and is proportioned for 12 men for maximum load. The trolley traverse is operated on one side only, and is accomplished by two chains, one on either side of the trolley to equalize the pull thereon. The main traverse is operated from both sides. The platform is supported on eight double tread wheels, each 42 inches in diameter, in such manner that each wheel will at all times support its proportional part of the load. The truck wheels have chilled faces, are ground true and to same size. A rigid support, which may be applied or withdrawn at will, is provided for each end of entire set of wheels carrying the gantry. Each support consists of a wedge operated by a lever and eccentric. A latch is provided at either end of the transfer car for locking the same to wall of runway, and notch castings are placed at the inner ends of the run offs respectively, into which the latch will lock, thus holding the car in place during the transfer of the gantry to the run off. The platform car is arranged to be traversed by hand power, the gearing being arranged for six men, three at either crank. The truck axles are of open-hearth steel and roller bushed.

The weight of the gantry complete is about 35 tons, and of the car 25 tons.

The drawing herewith contains a front and end elevation of the gantry and a section of the runway and car. A photograph is also forwarded of gantry carrying the 12-inch B. L. rifle, steel, with carriage complete. The plan of the proving ground shows the position of the runway in front of the main battery and the railroad to it from the wharf.

Field gun battery.

A substantial platform for field guns with two firing butts has been built at the points indicated on attached plan. It is protected by a wooden covering 50 feet long by 20 feet wide, and with its loading shed and other appliances forms a complete battery, at which experiments

with field guns may be conducted independently and simultaneously with those at the main battery with guns of heavier caliber. A plank road connects it with the main highway of the proving ground, and as in experiments with small guns frequent journeys to the instrument room are necessary, its proximity to the office building is a matter of great convenience.

The following papers, etc., are forwarded herewith:

Specifications of office building and barracks.

Pl. I.—Batteries and buildings. Pl. II.—East and west elevations office building. Pl. III.—First-floor plan office building. Pl. IV.—Front elevation and plans of barracks. Pl. V.—General elevation of gantry crane and cross section of car.

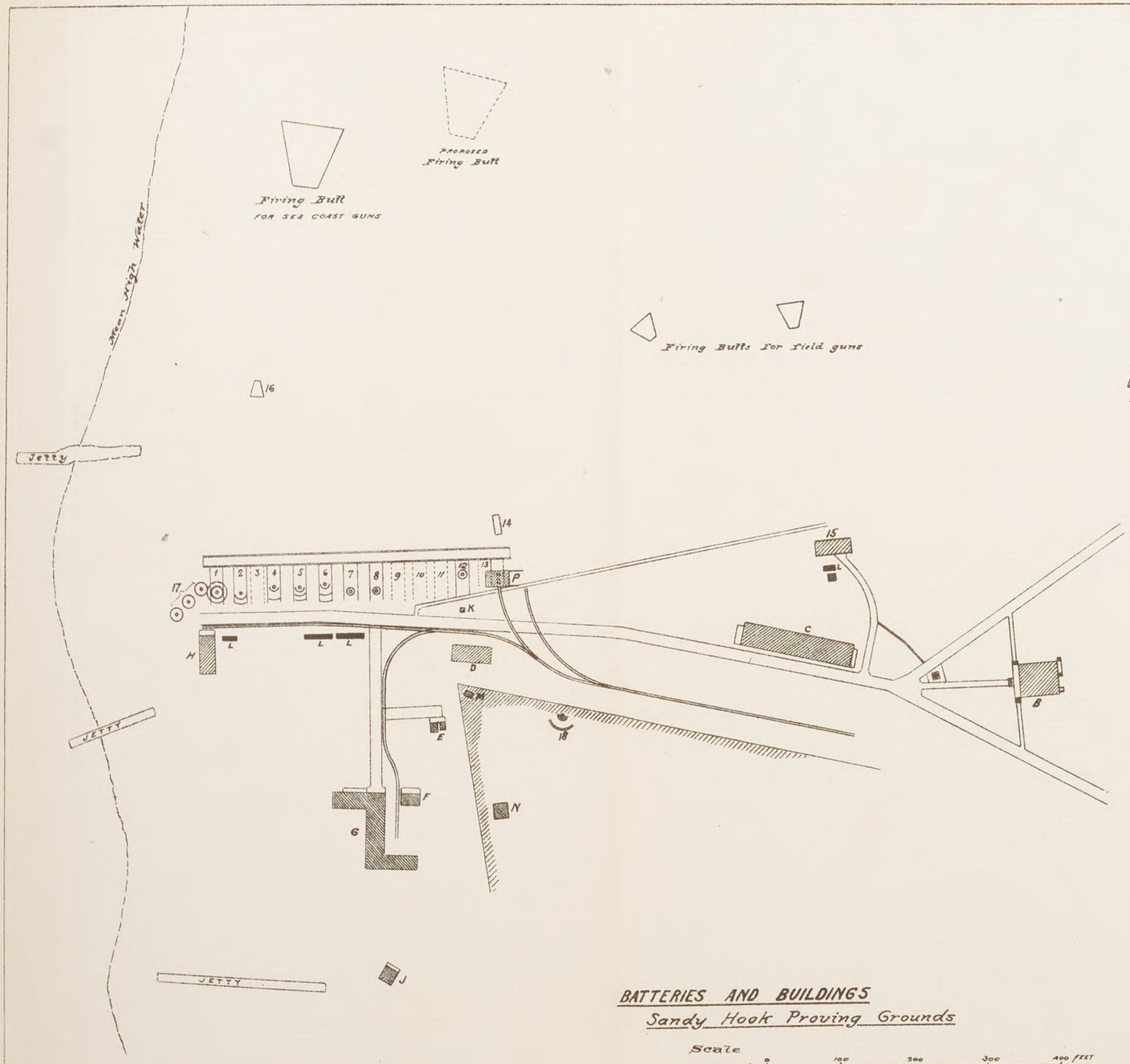
Photograph.—Gantry crane carrying 12-inch B. L. rifle, steel, and proof carriage, complete.

Very respectfully, your obedient servant,

FRANK HEATH,
Capt., Ord. Dept., U. S. Army, Commanding.

CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

(4852–'92.)



BUILDINGS

- A OFFICER'S QUARTERS
- B OFFICE
- C CARPENTER SHOP
- D TOOL HOUSE
- E CARTRIDGE SHED
- F PAINT SHOP
- G MACHINE SHOP
- H LOADING SHED
- J WESTERN UNION TELEG. TOWER
- K BELL
- L SAND SHELTERS
- M PLANE TABLE
- N OBSERVATORY
- P (PROPOSED) HOUSE FOR GANTRY CRANE

GUN PLATFORMS

1 GORDON'S
2 { 15" CARRIAGE ALTERED FOR 8" B.L. RIFLE STEEL AND FOR 12" B.L. MORTAR
3
4 8" PROOF CARRIAGE
5 10" " "
6 12" " "
7 FACEPLATE
8 "
9
10
12 EASTON & ANDERSON 12" MORTAR
13
RECOIL CARRIAGE
15 FIELD GUNS
16 HIGH EXPLOSIVES
17 (PROPOSED) BATTERY FOR RAPID FIRE GUNS
18 PNEU. DEPRESSING CARRIAGE FOR 10" RIFLE

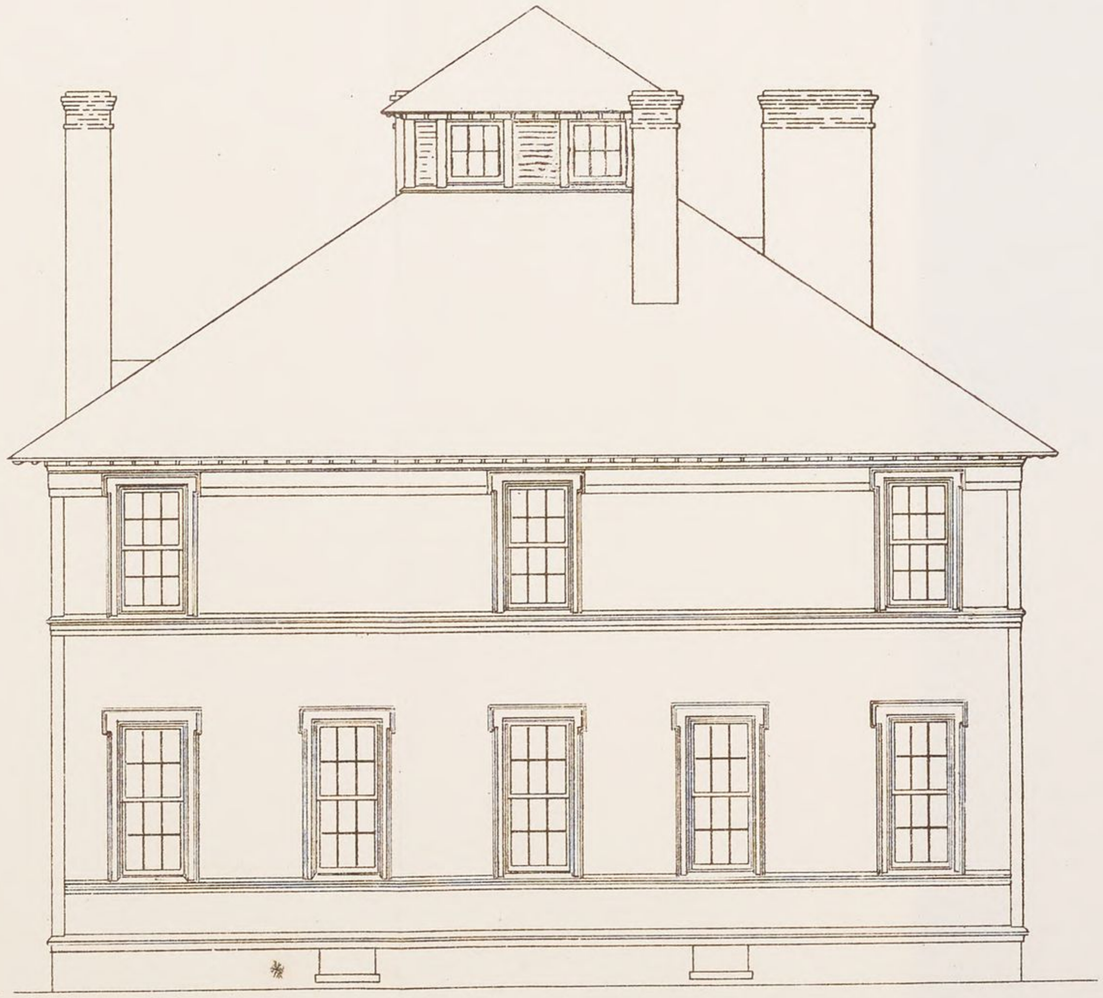
BATTERIES AND BUILDINGS

Sandy Hook Proving Grounds

Scale 0 100 200 300 400 FEET

SEPT. 13TH 1892.

East Elevation

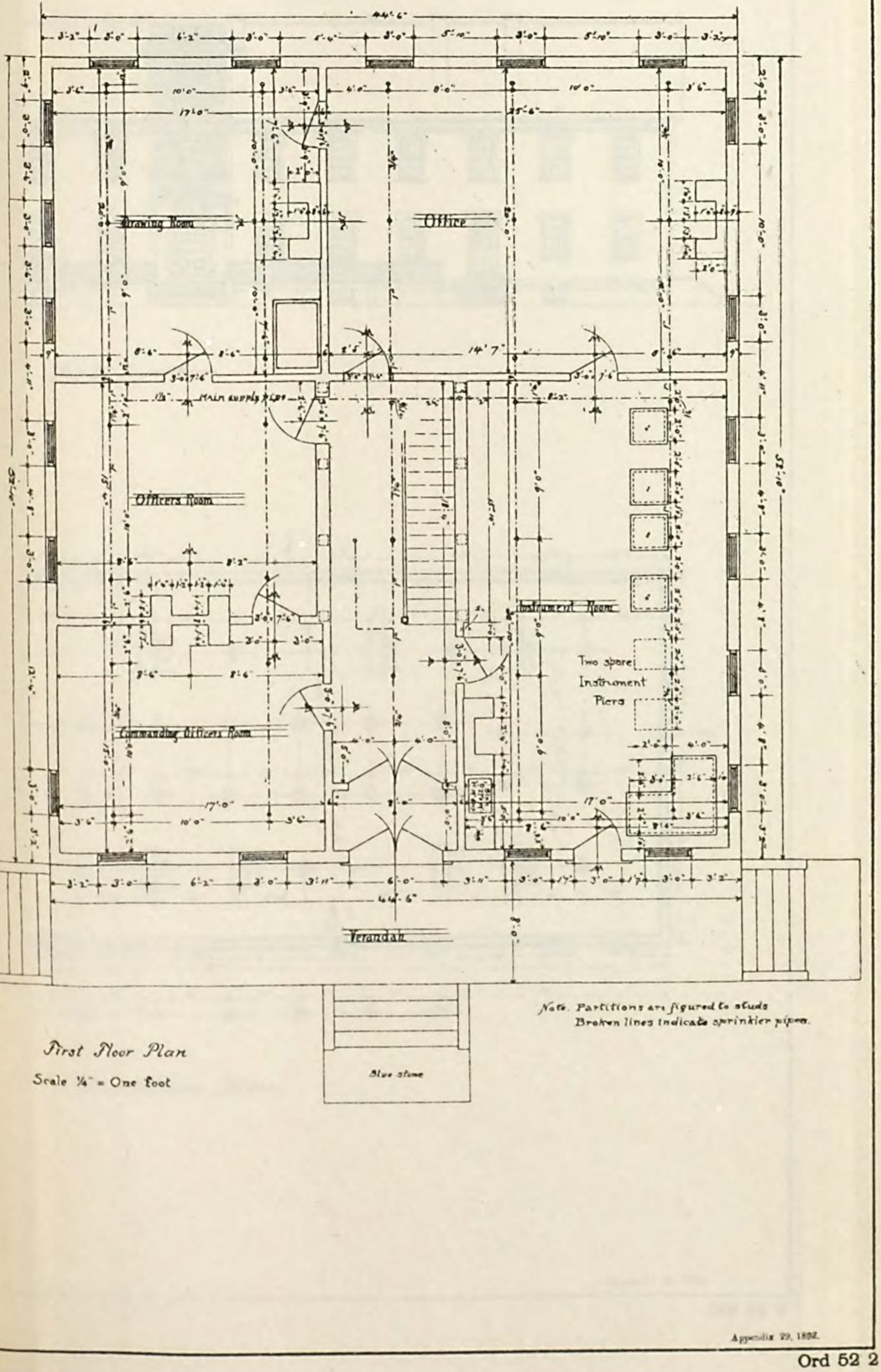


West Elevation

OFFICE BUILDING

SANDY HOOK PROVING GROUND

Traced from blue-print. Scale, ½ in. = 1ft.

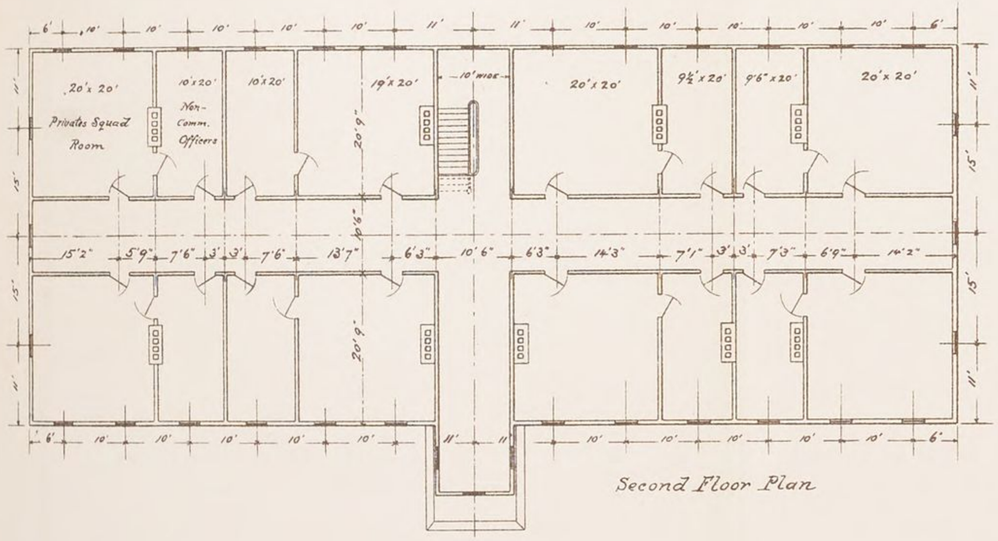


First Floor Plan

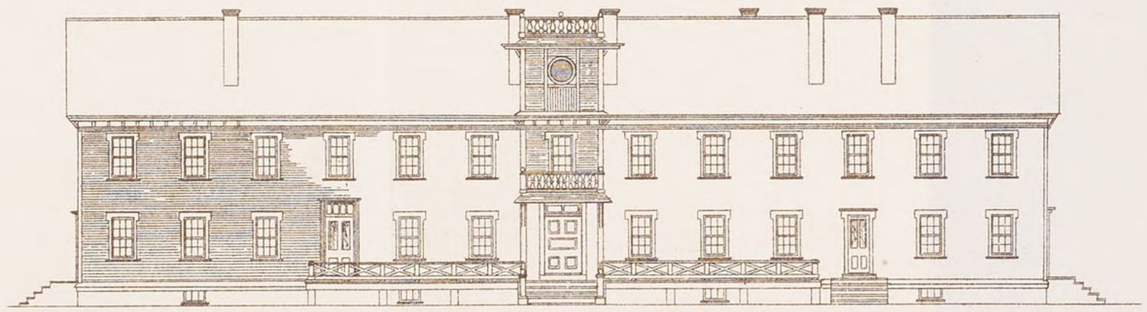
Scale ¼" = One foot

Note. Partitions are figured to studs
Broken lines indicate sprinkler pipes.

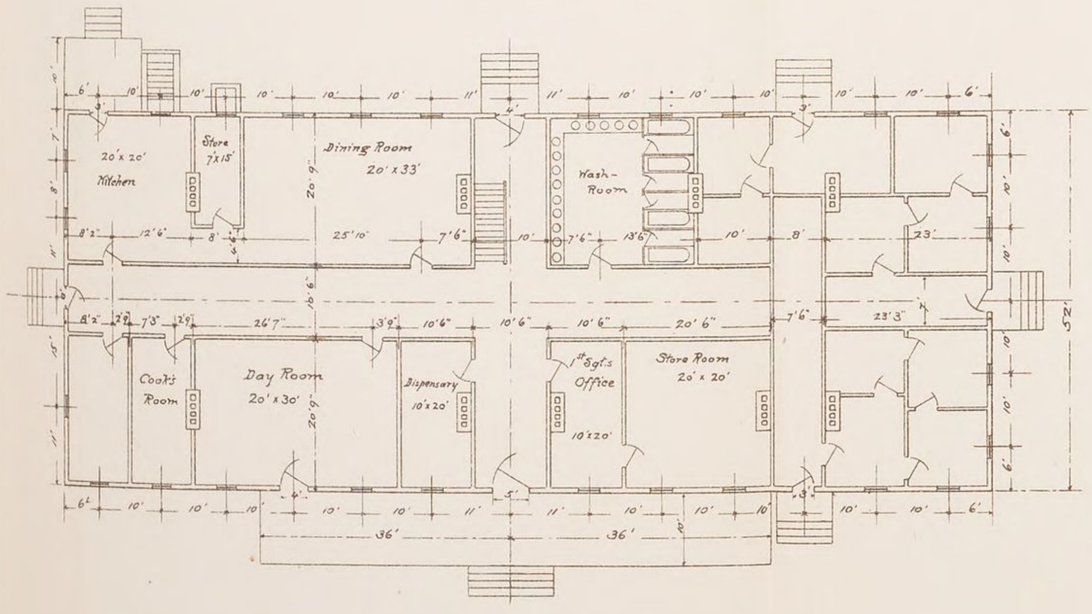
PLATE III.



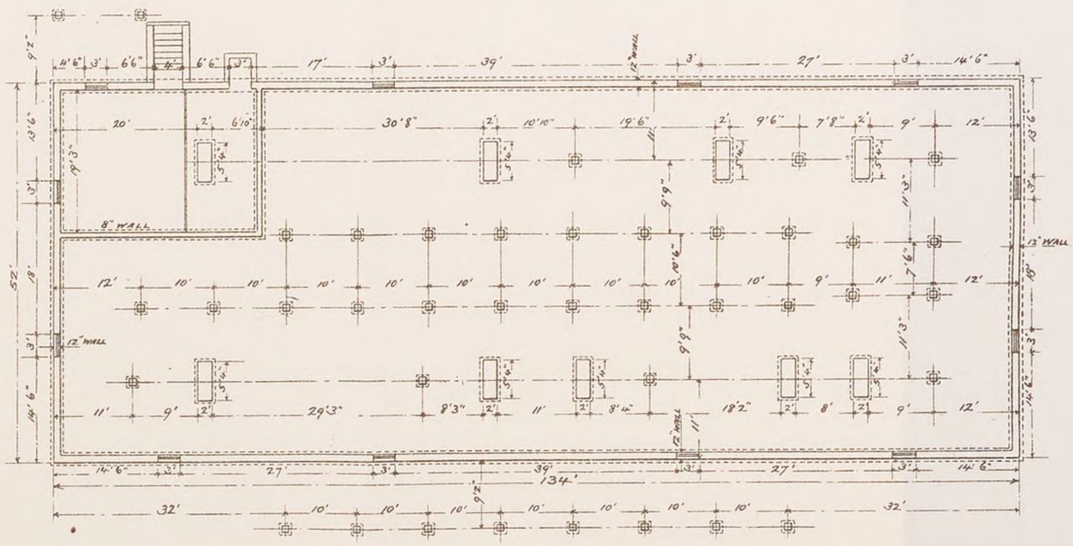
Second Floor Plan



Front Elevation



First Floor Plan



Foundation Plan

NEW BARRACK, For Ordnance Proving Ground, Sandy Hook, N.J.

FEET 10 20 30 40 50 60 70 FEET

Appendix 29, 1892.

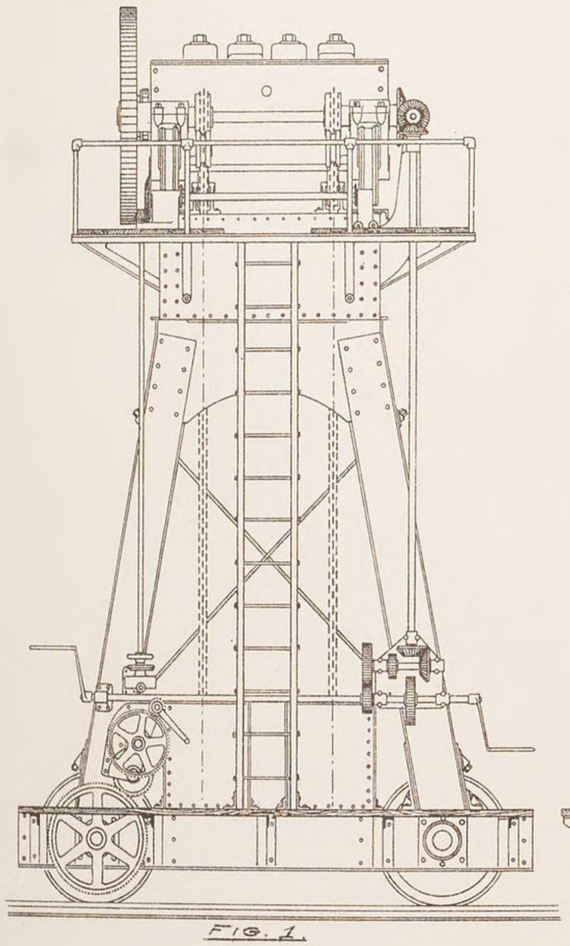


FIG. 1.

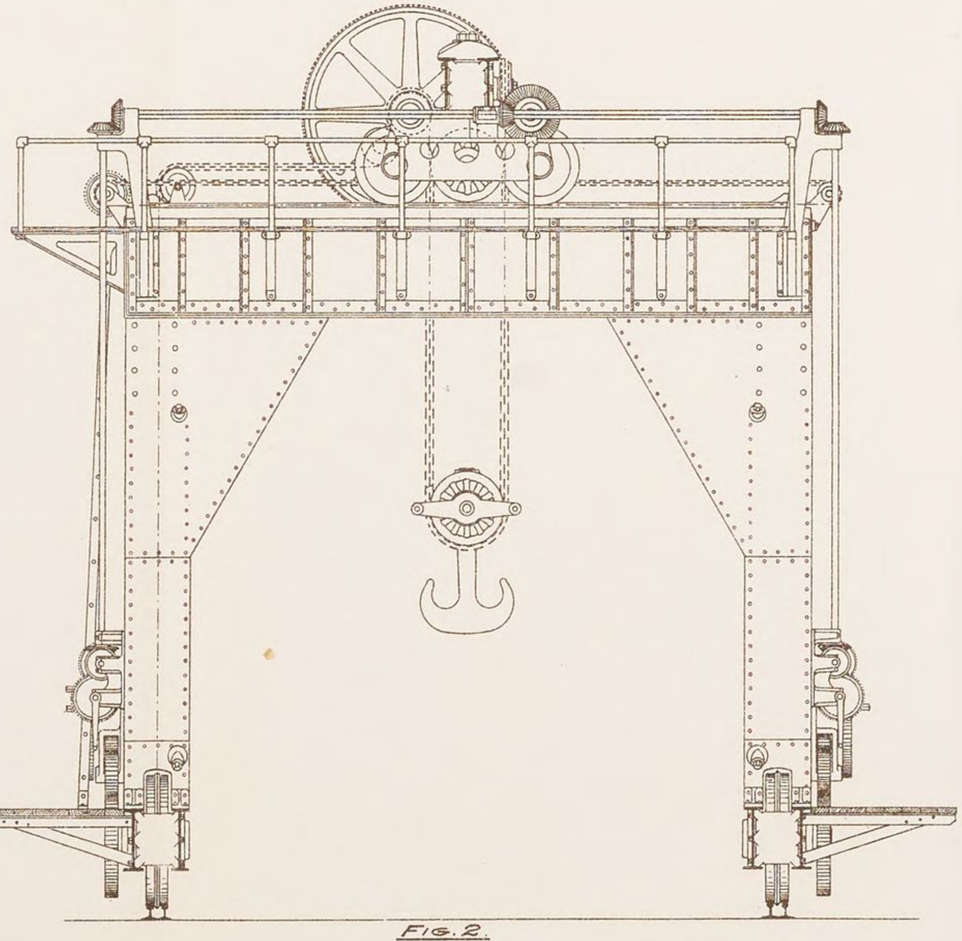


FIG. 2.

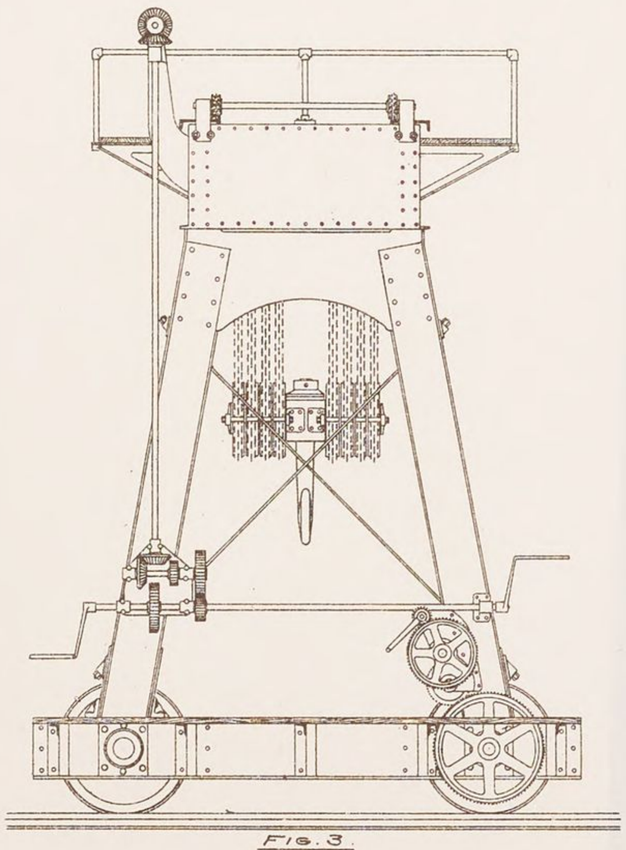
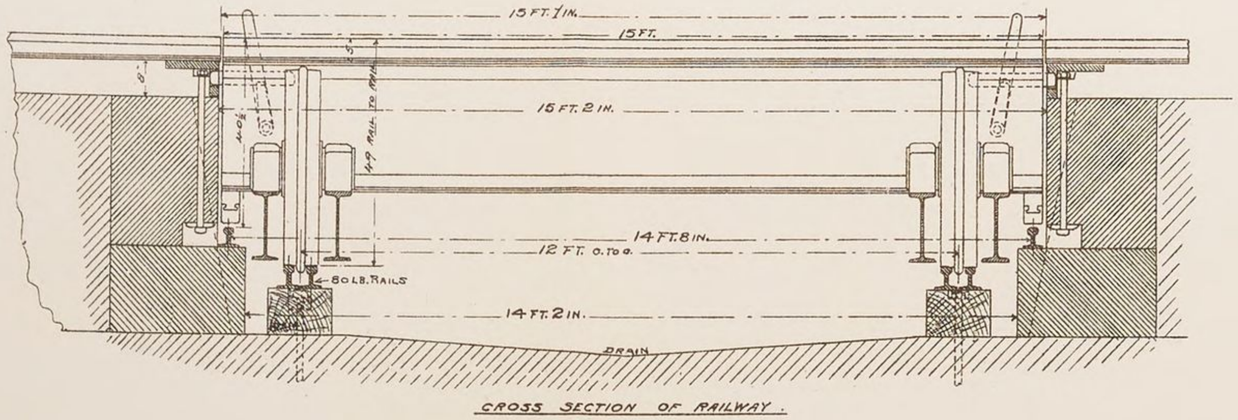


FIG. 3.



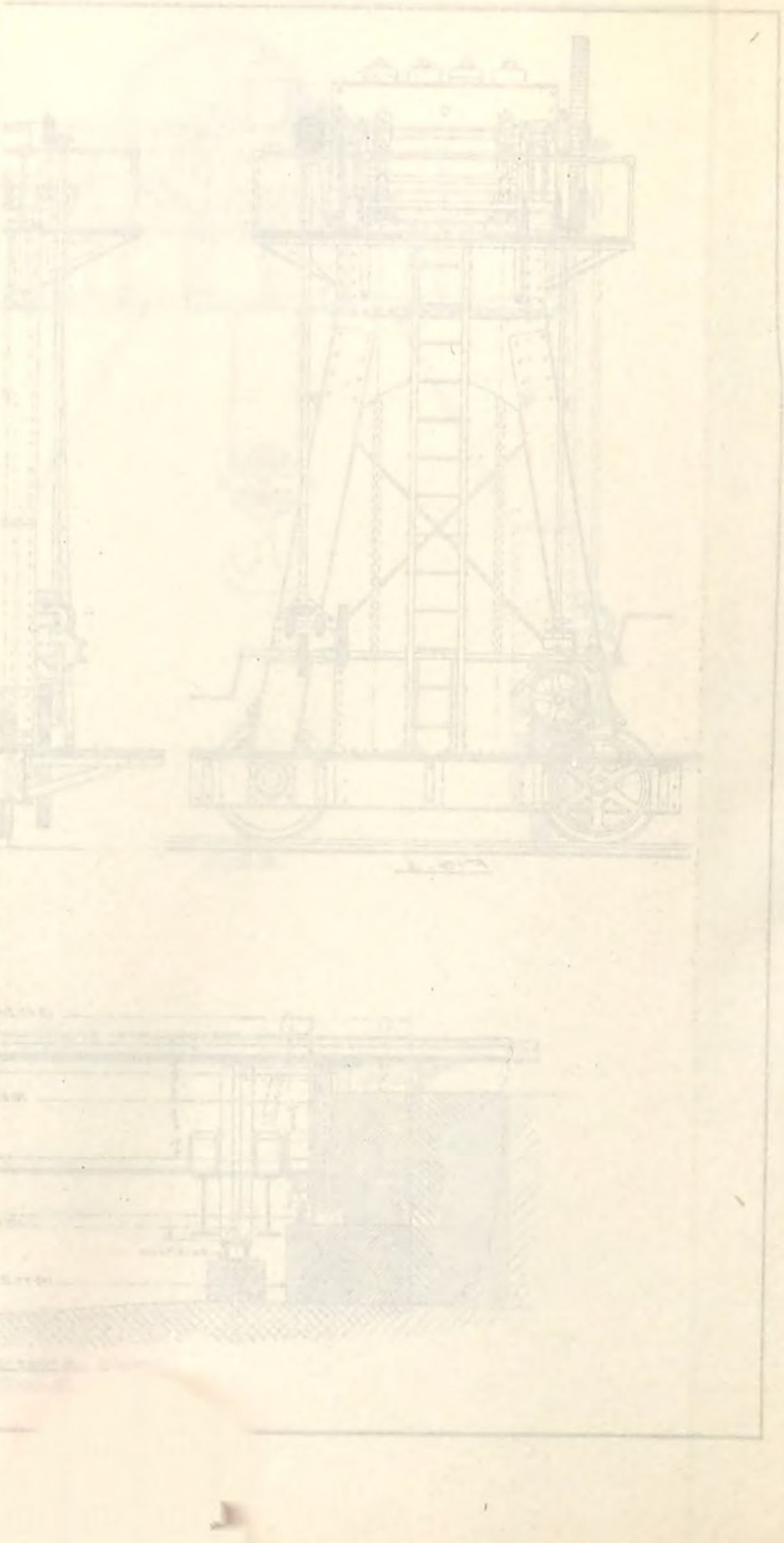
CROSS SECTION OF RAILWAY.
FIG. 4.

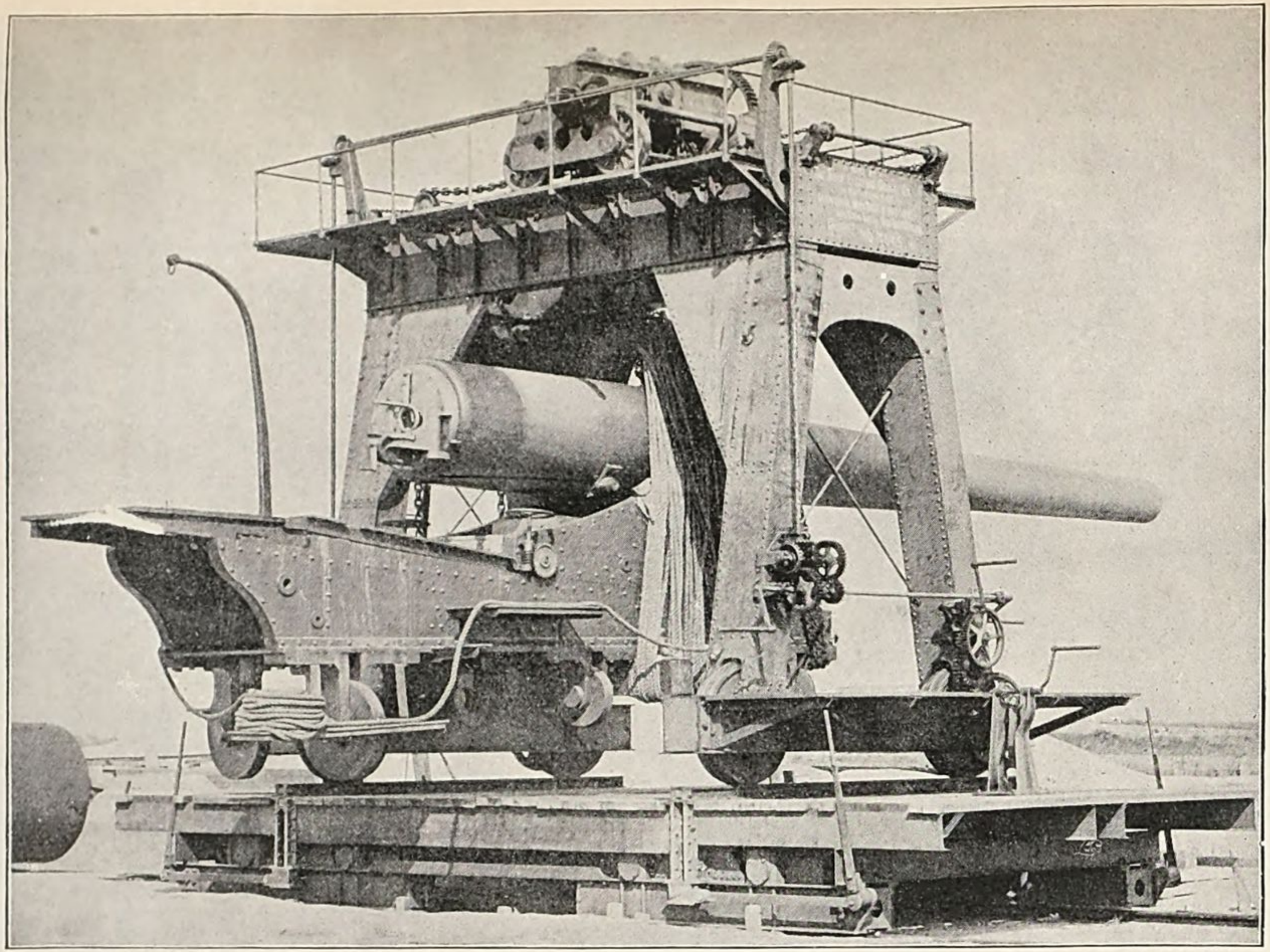
80 TON GANTRY CRANE

TRACED FROM THE SHAW ELECTRIC CRANE CO.'S BLUE PRINT OF NOV. 16–'91.

SCALE ½" TO 1 FT. ON FIG'S 1, 2 & 3.

" ¾" TO 1 FT. ON FIG. 4.





Appendix 29, 1892.

GANTRY CRANE: CARRYING 12-INCH B. L. RIFLE AND PROOF CARRIAGE, COMPLETE, SANDY HOOK PROVING GROUND.

APPENDIX 30.

SPECIFICATIONS FOR THE ERECTION OF A NEW FRAME OFFICE BUILDING FOR THE UNITED STATES ORDNANCE PROVING GROUNDS AT SANDY HOOK, N. J.

SPECIFICATIONS.

The proposed new office building for the United States ordnance proving ground will be situated, on site designated by the officer in charge of the post, not more than 1 mile from wharf.

The building will measure 52 feet 10 inches on north and south elevations, and 44 feet 6 inches on east and west elevations, not including the veranda and steps on the east front.

HEIGHT OF STORIES.

The finished first floor shall be 3 feet 3 inches above the general grade line, there being no basement under any part of the building. The first story 11 feet in the clear. Second story 9 feet in the clear. And attic 13 feet 6 inches to under side of ridgepole.

LIST OF DRAWINGS.

No. 1. Foundation plan, $\frac{1}{4}$-inch scale.
No. 2. First floor plan, $\frac{1}{4}$-inch scale.
No. 3. Second floor plan, $\frac{1}{4}$-inch scale.
No. 4. East and west elevations, $\frac{1}{4}$-inch scale.
No. 5. North elevation, $\frac{1}{4}$-inch scale.
No. 6. South elevation, $\frac{1}{4}$-inch scale.
No. 7. Section looking west and section looking south, showing construction for support of water tank in attic, $\frac{1}{4}$-inch scale.
No. 8. Details of battery table, work bench, etc., $\frac{3}{4}$-inch scale.

The work to be executed will be:

First.—Mason work, which includes necessary excavators' work, concrete work, brick masonry, bluestone work, removal of waste, and jobbing to complete the building.

Second.—Carpenters and joiners' work, which includes all necessary framing, floor beams, floors, roof framing and sheathing, studs, partitions, etc.

Roofers and tinners' work.—Exterior wood work—as window frames, sashes, glazing, doors, etc.

Stair-builders' work.—Inside finish, or joiners' work—including battery tables, hood and flue with sashes, work bench with vise and desk, bookcase, rack for storing stationary, etc., sashes in partitions, sheathing, doors, hardware, painting, and jobbing to complete the building.

Plumbing.—Which includes all water supply and waste pipes, sundry pipes with necessary traps, faucets, marble work, etc. Tank and supports of iron beams.

GENERAL PROVISIONS.

The contractor shall provide and furnish, at his own cost and charge, all transportation, good, sufficient and safe tools, implements, planking, scaffolding, runs, hoists, centerings, templates, molds, derricks, lifts, machines, and appliances of every description necessary or desirable for executing and completing in the best and most thorough manner the several kinds and the entire work specified and intended to be done.

The contractor is not to take advantage of any omission of details in specifications, models, or drawings, but will be required to do everything necessary to complete the work.

The contractor shall furnish all labor and materials of every kind and description used or intended to be used in any and all of the work, in every case the best of their several kinds, and fully approved by the commanding officer, who shall be afforded every facility for ascertaining and determining the skill and competency of such labor, and of examining, inspecting, and testing such materials as he may deem necessary. Skilled, competent, and fit workmen only shall be employed.

The contractor shall remove, after receiving notice in writing, all materials furnished and all work condemned by the commanding officer as not conforming to this specification or the drawings, and all other material furnished and work done that shall not be in accordance therewith.

The contractor will be held responsible for the general care, control, and good order of all the building operations carried on in and about the structures during the continuance and until the completion and acceptance of the work herein specified, and will be required to give all other contractors proper facilities for the prompt and thorough execution of their respective work in connection with his own.

The contractor shall provide and maintain in a clean, healthy manner, during the construction and until the completion and acceptance of his work, good, proper, and ample water-closets for the use of all workmen connected with the building.

The contractor shall employ only competent foremen for the different trades, who are to receive and carry out orders given by the commanding officer in the absence of the contractor, and who shall give any assistance that may be required to the commanding officer in connection with the work.

The contractor shall preserve stakes, bounds, bench marks made or established on or about the site of the work, until required to remove same.

The contractor shall not execute any work not originally included in the contract without a written order from the commanding officer, nor without a written agreement shall have been made as to kind and quality of work, and the charges to be allowed therefor.

Any work shown or noted on the drawings and not especially mentioned therein, or *vice versa*, shall be executed and supplied by the contractor, the same as if mentioned or shown in both, notwithstanding any errors or omissions in the one or the other.

The general dimensions are shown and figured on the several plans and detail drawings; the figured dimensions invariably to have the preference to scale measurements. Unless those measured are proved to be incorrect, such discrepancies shall be adjusted by the commanding officer.

The work shall be conducted under the direction of the commanding officer, who shall have power to prescribe the order and manner of executing the same in all its parts; of inspecting and rejecting materials, work, and workmanship, which, in his judgment, do not conform to the drawings that may be furnished from time to time, to the models, or to these specifications. And any material, work, or workmanship so rejected by him shall be kept out of or removed from the finished work, and no estimate or payment shall be made until such material, work, or workmanship be so removed.

SPECIFICATIONS OF THE MASONS' WORK.

The masons' work shall include all the necessary excavations and concrete work, brick masonry, bluestone work, removal of waste, and jobbing.

Excavators' work.—Excavate to the proper depth for all footings; remove and deposit as directed all superfluous materials for grading around the building, or final disposal at any point designated within one-half mile.

Bail or pump water from excavation, if necessary.

Filling.—Fill next to wall with good, clear soil, and ram down firmly as filling in progresses.

Grading.—Grade earth around building, if necessary, not exceeding 10 feet away from walls to finish a good even surface, using surplus excavated materials or other materials found on premises and designated to be used by the commanding officer.

STANDARD OF MASONS' MATERIALS.

Masons' materials shall be subject to the following mentioned tests, and conform to the following mentioned requirements before acceptance:

Hydraulic cement.—Fineness 90 per cent, to pass through a sieve 2,500 meshes to the square inch. Tensile strength, 50 pounds in 24 hours and 125 pounds in 7 days. Set in not less than 30 minutes, to stand a number 12 wire with a $\frac{1}{4}$ pound weight.

Sand.—Local sand, if found up to standard, may be used, but must be taken from banks above tide-water mark. Shall be clean, sharp, free from loam or other impure substances, and equal to standard first quality Cow Bay sand.

Broken stones.—Shall be sound material, granite, trap rock, or other hard limestone, screened, free from dust or dirt or decayed stone. Or gravel $\frac{3}{4}$ to $1\frac{1}{2}$ inches screenings.

Brick.—Shall be (hand made) hard burnt, of even quality, square and well shaped, free from checked or swollen or refuse brick, not more than three per cent to be bats, and nothing smaller than half bricks.

Concrete work.—Shall be laid in trenches 6 inches wider each side than the walls above, laid in one course 6 inches deep.

Compose concrete of one part best natural hydraulic cement, two parts clean sand, dampened and loosely measured, three parts broken or crushed stone, not over two inches in any way. Ram thoroughly and finish top surface level to receive walls above; protect sides of concrete with plank set edgewise and secured to the sides of trenches.

Instrument piers.—Build instrument piers complete of Portland cement, and cap with bluestone plates as shown. Compose concrete of Dyckerhoff or Hemmorr Portland cement one part, clean, sharp sand

three parts, clean, crushed limestone 1½ inches in size, five parts; mix on plank platform, first mixing materials dry, then adding the least amount of water to form parts of proper consistency. Ram into plank molds (made of 1½-inch plank firmly nailed at intersections) in layers of 8 inches each. When mold is stripped off, plaster outside surfaces with one per cent of Portland cement and sand about ¾ inch thick. Bed capstones in Portland cement and sand, mixed in proportion of one part cement and two of sand.

Brick work.—Build foundation walls, piers from concrete footing to the level of sills or top of floor beams, as indicated, with best quality common, hard burnt, South River brick of good shape, laid in hydraulic cement mortar, composed of one part first quality natural hydraulic cement and two parts of clean, sharp sand, well mixed and tempered. Thoroughly wet brick before building in the wall. Lay brick in full bed of mortar, filling end and side joints at one operation, and bedding same so close that nine courses of brick laid will not measure more than 2½ inches more than nine courses of brick laid dry. Run headers every fifth course. Strike joints in all flues and all exposed brick work. Build walls plumb, level, true by line and, as far as practicable, at same height. Rack back unconnected work to secure good and firm bond. Corbel out to receive veranda girders. No bats to be used except for closets. Bed all timbers. such as plates, girths, etc., laying on walls in a bed of mortar ¾ inch thick. Lay all brick work of chimneys above the roof with selected brick, laid in Portland cement and sharp sand, in the proportion of one part cement two parts sand. Strike joints neatly.

Fireplaces.—Build fireplaces with buff pressed brick, laid in white mortar, extra close joints; pave hearth with the said brick laid on edges; use molded brick for jambs and lintels.

Bluestone work.—Bluestone work, to include flagstone, quarry faced at foot of main entrance; quarry face and edge window sills 5 by 8 inches washed, good fine axed work. Chimney caps and instrument pier caps, fine axed top and sides, perfectly true. Cut all bluestone work from selected bluestone, either North River or Delaware quarries, carefully drilling holes in instrument pier caps, as shown on detail drawings. Post plates—axed bluestone 8 by 12 by 20 inches, to receive posts supporting tank.

CARPENTERS AND JOINERS' WORK.

Comprises frame, studding, partitions, etc.; roof timbers, bridging, sheathing, under and top floors, roofing, exterior wood work, window frames, sashes, glazing, etc.; stair-builders' work, inside finish or joiners' work, hardware, painting, jobbing, etc., to complete the building, besides interior fittings shown on drawing No. 8.

Frame.—Lay on walls for sill 6 by 6 inches, Florida yellow pine timber, in lengths of not less than 20 feet, spliced 1 foot where required and halved at corners.

Bed the sill in a heavy bed of cement prepared by the mason.

Construct the frame from the sill to and including the roof timbers of good seasoned hemlock or spruce.

All studding 2 by 6, 12-inch centers; posts 8 by 8; ties 2 by 8; plates 4 by 6; girths 6 by 8, etc.; rafters 2 by 8, 10 and 12 inches, 18-inch centers; braces of 3 by 6 North Carolina yellow pine; ceiling timbers of 2 by 10, 18-inch centers.

Construct first and second tier of beams with either North Carolina

pine or spruce timbers, 3 by 10, spaced over 14-inch centers. Double timbers at stair well, chimney breasts at sides of instrument piers, and under partitions.

Double stud for door and window posts and heads.

Frame headers into trimmers, or support on patent bridle irons.

Bridge each span of beams, where over 8 feet, with 2 by 3 cross bridging, firmly spiked at each end with 20*d.* nails.

Sheathing.—Sheath the entire frame, walls, floors, and roof with best selected hemlock boards, free from large or loose knots, dressed, matched, 1 by 6 inches, nailed on frame diagonally, well spiked to the timbers twice at each intersection. Break joints so that no two joints will come side by side on the same stud or rafter.

Paper lining.—Previous to nailing on clapboards or shingling, cover the sheathing above mentioned, walls, and roof with Anchor brand tarred paper, lapping at edges not less than 2 inches.

No more paper to be put on sheathing boards than can be covered by either clapboards or shingling during the day.

Shingling.—Shingle the entire roof with 20-inch cypress shingles, showing 5 to 5½ inches to the weather.

Work around chimneys for flashings 14-ounce copper, worked 2 inches into the brick work; average 5 inches on sides and 3 inches under the shingles. The flashings to be counter flashed on three sides, while the back of chimneys to be close flashing.

Outside finish.—Trim windows, doors, corner boards, water-table belt or sill course, cornice with false rafters, soffits, etc., complete, with seasoned, good, sound white-pine plank, free from large or loose knots, sap, or other imperfections.

Trim doors and windows with architraves ⅞ inch thick with molded and back band.

Water table of 1⅛ to 1¾ inch stuff, molded.

False rafters 2⅞ inches thick, scroll sawed.

All the outside finish plane smoothed by machinery true and square, or molded as shown.

Line the window and door heads with strips of tin, painted twice, both sides, before being laid; extend tin 3 inches under clapboards and over the ledge, then nail in front of cap.

Clapboarding or siding.—Cover all vertical walls of building between and over doors and windows from the water table to the roof with first quality extra clear white pine, beveled sidings 6 inches wide, to show not over 4¾ inches to the weather. All butt joints leaded as the work progresses.

Window frames.—Complete of clear white pine, 2-inch rebated sills, 1⅛-inch pulley stiles, ⅞-inch casing, ⅝-inch parting strips, ⅝ by 2 inch stop beads.

Sashes.—Fit to all windows clear white-pine sashes, molded, framed, primed, and jointed in white lead, not less than 1¾ inches thick.

Transom sashes same thickness as doors.

Glazing.—Glaze all windows, sash doors, and transoms throughout with first quality double-thick American sheet glass, free from specks, waves, or defects.

Bed all glazing in putty, brad with zinc brads, and putty with best quality putty.

Clean off glass on arrival at building for inspection before putting up.

Make good breakage and leave glass in a perfectly clean condition when work is completed.

Basement windows.—Set in basement window openings rebated frames of 2-inch white pine. Fit with $1\frac{1}{8}$-inch paneled shutters; hang at bottom, swing inward, and fasten with bolts or hooks from outer side.

Top floors.—Lay for top floors seven-eighths 3 to 4 inch clear quarter cut or comb grained North Carolina pine, tongued and grooved, slow fed, plane smooth long in courses, well blind nailed, and breaking heading joints. When all joiners' work is completed plane off top floors to dead level.

Provide a trap door 3 by 4 feet for access to air space under the building. Also trap door in ceiling of second floor for access to cock-loft, and two trap doors without hardware, one over each spare instrument pier.

Inside or joiners' work.—Trim the interior of building, including all the ceiling, with selected clear North Carolina pine, extra kiln-dried.

The doors throughout the house will be clear white pine, selected No. 1 doors.

Ceil walls and ceilings with $\frac{7}{8}$ by 3 inch tongued and grooved and beaded North Carolina pine ceiling boards, dressed to an even thickness, and not to show planers' marks.

Nail in courses, blind nailing to each stud; break joints and form butting joints with planed butt ends. Smooth off work before varnishing. Skirt all walls with a molded base 6 inches high, $\frac{7}{8}$ inch thick, and with a molded chair rail $\frac{7}{8}$ by $4\frac{1}{2}$ inches wide, firmly nailed to walls. Trim around top of walls next to ceiling with a molded picture strip $\frac{7}{8}$ by 3 inches wide, well blind nailed to the walls.

Doors.—Hang to all doorways throughout clear white-pine doors, selected No. 1, perfectly clear from imperfections of any kind. Four or five panels, flushed moldings, all well glued, wedged, and put together in the best manner. Sash doors as shown. All interior doors $\frac{3}{4}$ inch thick. Exterior doors $2\frac{1}{8}$ inches thick, jambs $1\frac{3}{8}$ inches thick, rebated $\frac{1}{2}$ inch to receive the doors. Architraves 4 inches wide by $\frac{7}{8}$-inch molded, and finishing to corner block and base block.

Saddles of $\frac{5}{8}$ by 4 inches wide, and even molded.

Stairs.—Build one run of stairs from first to second story with open strings, facia, newels, baluster, rails, and soffit ceiling complete, of selected kiln-dried clear North Carolina pine. Treads and strings $1\frac{3}{8}$ inches thick, molded and returned nosings, molded strings, $\frac{7}{8}$-inch risers, wedged; glue house block of treads and risers into the strings, and support in 3 by 7 inch horses or timbers.

Newels.—6 by 6 inches, fancy turned at foot and head of stairs.

Baluster.—1 by 2 inches, square edged.

Rail.—3 by 4 inches, or equivalent, molded.

Ceil under side of stairs same as walls and ceiling.

Build one stepladder for access to the tank tower, complete, of clear white pine, $1\frac{1}{2}$-inch sides and $1\frac{1}{8}$-inch treads; line under sides with sheathing used for ceiling. Close at ceiling with a trap door of same materials as ceiling.

Build one stepladder for access to the air spacing under building, complete, of North Carolina pine, $1\frac{1}{2}$ strings and $1\frac{1}{8}$ treads.

Build outside steps complete of clear white-pine strip $1\frac{3}{8}$ by 3 inches, set $\frac{1}{4}$ inch apart; horses 3 by 6 inches will support on chestnut posts planted 4 feet in the sand. Facias of $1\frac{1}{8}$-inch white pine.

Veranda floors.—Lay 4 by 8 inch plates, 3 by 8 inch spruce beams, 16-inch centers; cover with $1\frac{1}{8}$ by 4 inch square edge clear pine, spaced $\frac{1}{4}$ inch, in lengths from building to edge without butting joints; round off nosings; facia of $\frac{7}{8}$ clear pine. Steps as above specified.

Cases, etc.—Shown on drawing No. 8. Build cases, workbenches, and other fittings, complete, of selected ash of sizes shown.

Hang around the battery chamber sets of counterbalance doors or sashes, so hung as to allow the use of $\frac{3}{4}$ round brass rods for ways.

Build air-tight vent flue connecting battery table hood to flue in chimney of $\frac{7}{8}$-inch tongued and grooved white pine, then cover with sheathing paper above specified, and cover with an outside casing of $\frac{7}{8}$-inch white pine tongued and grooved boarding.

Use bronze-faced pulleys with brass wheels and Giant metal sash chain.

Pigeonhole case.—With pigeonholes inclosed by doors; stationary cases with shelves, etc. Work bench with solid 2-inch top, properly doweled and fastened.

Hardware.—The contractors shall furnish, fit, and fix securely all necessary hardware for windows, doors, casings, etc., throughout, of the size required, with all necessary fastenings and attachments, as follows: Hardware throughout to be of the best quality real bronze or cast or wrought iron, as further specified, all from first-class manufacturers, each piece subject to selection and inspection, and shall be provided with proper screws.

Secure and make fast doors with locks, and the standing leaves of double doors with bolts, top and bottom.

Sash generally hang with Silver Lake linen sash cord over sash pulleys, counterbalanced with solid eye cast-iron weight. Transom or pivot sashes control with transom lifters of approved make, mortised sockets, sash fasteners, etc. Door hinges and closet sashes, etc.; sheaves, tracks, and fastenings complete.

Locks.—Entrance doors 6 by 4 inches, extra heavy wrought lock with night-latch attachment, three or more tumblers, bronze fronts, rebated bolts and strikes, japanned iron cases, six steel or metal keys to each, dead bolts and night-latch. Three-inch plain bronze knobs, with rose and escutcheon combined. Double fixtures to double doors. Interior door locks 5 by 4 inches, three tumblers, bronze front bolts and strikes, japanned boxes. Three steel or white metal keys to each lock. Tag *all* keys throughout, and mark tags and locks from one upward and consecutively, also the name of the room required.

Knobs with rose and escutcheon combined, solid bronze.

Butts.—For doors loose-jointed cast-iron butts, 5 by 5 inches or more, to swing door past trim.

Bolts.—To all folding doors bronze-faced flushed extension top and bottom bolts, with handles within easy reach.

Pivots.—To transoms, of approved make.

Axle pulleys.—Plain bronze-faced, brass, square, grooved wheels, not less than $2\frac{1}{2}$ inches in diameter.

Sash cord.—Silver Lake linen cord.

Sash weights.—Cast iron, solid eye, round ends.

Sash fasts.—Bronze, Hopkins & Dickinsons's, or Corbin's.

Transom sash lifts.—Bronze, equal to Wollensack's, placed to operate transom sash with ease.

Hat and coat pins.—Put up as directed, heavy pattern, cast iron, coppered.

PAINTING AND POLISHING.

Preparations of wood work before delivery: Bring all exposed portions of wood work to a fine, smooth surface, and sand paper the same. Prime all rough parts of backs of window frames, casings, jambs,

architraves, trimmings, generally, with one heavy coat of metallic paint and pure linseed oil, without admixture of either benzine or petroleum. Paint or finish all exposed surfaces one coat before delivery at building.

After wood work is put in place, putty-stop smoothly and neatly, and before painting and finishing proceeds. Paint all exterior parts of building, such as clapboards, eaves, corner boards, window and door frames, sashes, etc., three coats of best white lead and pure linseed oil, tinted as directed. Paint the outside and inside of vent flue and battery table hood as above specified.

Polishing.—After wood is cleaned off, give three coats of best spar composition. Rub down each coat with sand paper before succeeding coat is laid on. Rub down last coat with crude petroleum and pumice stone to a good even polish. Oil twice the exposed surface of yellow-pine pulley stiles, and rub down each coat. Paint all iron work exposed to view, both inside and outside of building, two coats of pure white lead, paint tinted as directed.

PLUMBERS' WORK.

Comprises water supply and waste pipes. Also all distributing pipes with automatic sprinklers, as shown on drawings, necessary to complete the sprinkler system.

Tanks, safe and necessary supports of iron beams.

Water-supply pipes.—Carry a line of 2-inch galvanized wrought-iron pipe, well secured to walls, etc., from the level of first floor to and discharging in the tanks as supply pipe, and a $1\frac{1}{2}$-inch overflow pipe.

From the tanks carry a line of galvanized-iron pipes as shown on plans.

Use entirely heavy galvanized wrought-iron pipe, with heavy galvanized gray iron fittings; at every change of direction place a Y-fitting, with brass cap, for cleaning-out purposes.

Carry overflow 10 feet outside of building.

Sinks.—Set up complete in second story three sinks of size given, of 1-inch soapstone, well put together with cement, etc. In first story: Two cast-iron sinks, galvanized. Support same on wrought-iron brackets, galvanized or pipe standards, as directed. Soil pipes from same. Use down lines of 2-inch pipe; when two lines are connected increase to 3-inch pipe.

Waste through brass strainer, plug, chain, etc., complete.

Tank.—Put up complete two tanks, one 6 feet deep, 8 feet diameter, and one 6 feet deep, 6 feet diameter, of $\frac{1}{4}$-inch wrought iron, well riveted, chipped, calked; trim upper edge with an angle iron 3 by 3 inches.

Set a safe of $\frac{1}{4}$-inch iron, made 12 inches larger in diameter than the tanks, under the tanks as shown; 2-inch galvanized wrought-iron pipe from this safe to the sink in semiobscure room.

Support each tank on nine 4-inch iron beams and two 7-inch beams.

Paint all wrought-iron work three coats of Prince's metallic paint.

Connect as directed one 2-inch galvanized wrought-iron pipe for overflow discharge at side of building, and protect outlet with self-closing cap.

Connect a tell-tale pipe, $\frac{3}{4}$-inch galvanized wrought iron, from tank to a small sink, 12 by 12 by 16 inches, placed under main stairs, and discharging water through a connection made to the overflow pipe.

Automatic sprinkler.—Connect the tank with a 3-inch riser pipe run-

ning from bottom of tanks to a point under the ceiling of first floor. The sizes of pipe should conform to those marked on plans. Attach to said 3-inch riser pipe a 3-inch gate valve for controlling the water supply. Also on said riser should be attached a 3-inch alarm valve. A 10-inch alarm gong is to be placed in the second-story hall, and so arranged as to operate upon the opening of any sprinkler.

Use approved sprinklers, equal or superior to the new Grinnell sensitive automatic sprinklers, placed 10 feet apart, as shown on plans.

The whole system to conform as nearly as possible to the rules laid down by the New York Board of Fire Underwriters.

The pump for filling the tanks is to be provided and set by other parties.

SPECIFICATIONS OF THE MASONS' LABOR AND MATERIAL REQUIRED IN THE ERECTION AND COMPLETION OF A FRAME BARRACKS FOR THE UNITED STATES ORDNANCE DEPARTMENT AT SANDY HOOK, N. J.

The proposed building will be situated on ground designated by the commanding officer, not more than 1 mile from the wharf.

The building will be rectangular in shape, measuring 52 by 134 feet. The finished first floor shall be 3 feet 10 inches above the general grade line. There will be a cellar and coal bin under the kitchen, as shown by plan. Both stories will have 10 feet in the clear.

The building will be built according to these specifications and accompanying drawings, together with such additional details and explanations as may be necessary from time to time to insure the thorough completion of the work. All materials are to be the best of their several kinds, and all work executed in a substantial and workmanlike manner, under the superintendence and to the complete satisfaction of the commanding officer of the United States proving ground.

DRAWINGS.

All dimensions are to be taken from the drawings as shown by the scale marked thereon, and figures to be taken in preference to measurements in all cases. If discrepancies are found to exist, they will be adjusted by the commanding officer. The specifications are intended to explain the drawings, and therefore anything mentioned herein and not shown on the drawings or shown by the drawings and not mentioned by these specifications is to be executed the same as though represented by both.

EXCAVATIONS.

Make all necessary excavations for carrying out the herein-specified work to the depth required. Excavations to be made 1 foot larger than wall line, and all superfluous material removed from premises, as directed. Excavate to a depth of 6 feet below highest point of ground for chimneys, cellar wall, and cellar entrance, and to a depth of 3 feet for all other walls and piers. Excavate for cellar over the area shown and to the necessary depth, and carefully level all excavations. Bail or pump water if necessary.

FILLING AND GRADING.

Brace all walls, and when they are properly seasoned fill in around them with clean sand in layers well rammed down. Fill in all holes and trenches, and grade as directed, and remove all surplus earth and rubbish.

BASE COURSE.

Under all brick work lay base course, 12 inches thick and 8 inches wider than masonry above, of concrete, mixed in proportions of one barrel of Rosendale cement to two barrels of clean, sharp sand, and five barrels of machine-broken stone of a size to pass through a ring 2 inches in diameter, to be thoroughly mixed and well rammed down. Finish top surface level to receive walls above. Protect sides of concrete with plank set edgewise and secured to sides of trenches.

Broken stone shall be sound material, granite, trap rock, or other hard limestone, screened free from dust or dirt or decayed stone.

Brick shall be good hard-burnt brick, of even quality, square and well shaped, free from checked or swollen or refuse brick; not more than 3 per cent to be bats, and nothing smaller than half bricks.

BRICK WORK.

Build foundation walls from footing course to level of sills with best quality common hard-burnt South River brick, laid 9 courses to 24 inches. All brick work to be laid in cement mortar, of one part Rosendale cement to two parts of clean, sharp sand. All bricks well shaped and of uniform size, must be laid with joints thoroughly flushed up with mortar and well bonded, filling end and side joints at one operation. Run headers every fifth course. Bricks to be well wetted and exposed joints to be struck. All flues to be carefully built with joints filled, struck smooth, and cleaned out at completion. Build walls plumb, level, true by line, and, as far as practicable, at same height. Lay all brick work of chimneys above the roof with selected brick. Strike joints neatly. Chimneys to be provided with proper thimbles and holes.

Build outside cellar steps, bluestone treads with brick risers and sides. Build coal chute of brick, as shown, with bottom of concrete 4 inches thick; the bottom of the chute will slope at an angle of 45 degrees to bottom of window. Sand may be taken from banks above high-water mark, and must be clean, sharp, free from loam or other impure substances, and equal to standard first-quality Cow Bay sand.

BLUESTONE.

Provide and set caps for chimneys not less than 3 inches thick, the flues to be worked out of the solid and edges axed.

Caps for all piers to be 12 by 12 inches and not less than 3 inches thick. Stone treads for cellar steps to be 3 by 14 inches. Cellar-door sill to be 2½ inches thick and full width of wall, projecting 2 inches each side of opening into wall. Stone coping for wall of cellar steps, 2 inches thick.

CELLAR BOTTOM.

The cellar bottom is to be leveled off and concreted. The concrete to be 3 inches thick, and to consist of one part Rosendale cement to two parts of sand and five parts machine-broken stone, to be well rammed

down and leveled and made smooth, and then to be top finished with 1 inch pure Portland cement.

LATHING AND PLASTERING.

All partitions, ceilings, walls, and stairways to be lathed and then plastered three good coats. Lath to be narrow, well-seasoned pine lath, free from knots, and well nailed with a space of $\frac{3}{8}$ inch. Joints to be broken every ten courses, and lath to be run through alternately at angles.

First coat of plastering to be scratch coat; second to be a brown coat, finished to receive hard finish. Scratch and browning to have one bushel of well-whipped hair, free from grease and dirt, to each barrel of lime. The hard finish to be mixed in proportions of plaster of Paris, lime, and white fresh-water sand to make a hard and durable coat free from cracks, blisters, or other imperfections. All plastering mortar to be made up two weeks before using, and none but the best quality Rockland finishing lime to be used. All plastering is to be worked to ground, screeded plumb and straight rodded, and rendered hard by troweling, and to be left perfect at the completion of the work. Plastering to go to the floor. Patching to be done after other mechanics.

SPECIFICATIONS OF THE CARPENTERS' LABOR AND MATERIALS REQUIRED IN THE ERECTION AND COMPLETION OF A FRAME BARRACKS FOR THE UNITED STATES ORDNANCE DEPARTMENT AT SANDY HOOK, N. J.

The building will be built according to these specifications and accompanying drawings, together with such additional details and explanations as may be necessary from time to time to insure the thorough completion of the work. All materials are to be the best of their several kinds, and all work executed in a substantial and workmanlike manner under the superintendence and to the complete satisfaction of the commanding officer of the United States ordnance proving ground.

DRAWINGS.

All dimensions are to be taken from the drawings, as shown by scale marked thereon, and figures to be taken in preference to measurements in all cases; if discrepancies are found to exist they will be adjusted by the commanding officer.

These specifications are intended to explain the drawings, and therefore, anything mentioned herein and not shown in the drawings, or shown by the drawings and not mentioned in these specifications, is to be executed the same as though represented by both.

TIMBER.

All the timber is to be of good quality seasoned spruce or hemlock (unless otherwise distinctly specified), free from knots, shakes, splits, or other imperfections, sawn square and full sized; all to be carefully framed and braced in all parts, securely wedged and spiked. Headers to be framed into trimmers, and both to be kept clear of chimneys.

SIZE OF TIMBER.

Sills to be 8 by 8 inches, in lengths not less than 20 feet, spliced 1 foot where required, and halved at the corners.

Posts 4 by 8 inches, plates 4 by 6 inches, studding 3 by 4 inches, placed 16 inches from centers, and doubled at doors and windows.

Floor beams to be 10 by 3 inches, placed 16 inches from centers. Rafters to be 10 by 3 inches, placed 20 inches from centers. Ridge piece of 2-inch stuff.

Beams to be carefully leveled on walls, girders, and partitions, and doubled at stairwells and under partitions.

FRAMING.

All posts to run to height of building, to be mortised into sills, and braced by framed inclined pieces. At intervals of about 13 feet, 4 by 6 inch posts will be run up to roof and will be mortised to receive plates. Carefully truss over large openings.

The roof will be framed as shown. The inclined 3 by 6 inch pieces will be undercut and properly bolted both to rafter and tie beam, and the rafter and tie beam will be let into each other and firmly secured. The tower will be finished as shown by side and front elevation. In each end of building will be slatted window, the same as those in bell tower.

BRIDGING.

All floors to be bridged once in about 7 feet with a straight continuous row of double herringbone cross bridging of 1 by 4 inch pieces, cut in and nailed with two nails at each end of piece.

PARTITIONS.

Set all partitions of 3 by 4 inch stuff to run through the floor to avoid shrinkage. Double the studding at doors and under cross partitions. Bridge once in height with 2 by 4 inch pieces.

WINDOW FRAMES.

All window frames to be made "box" complete, of clear white pine, for hanging $1\frac{3}{4}$-inch sash with weights of the usual pattern; $1\frac{1}{2}$-inch rebated sills; $1\frac{1}{8}$-inch pulley stiles; $\frac{7}{8}$-inch casing; $\frac{5}{8}$-inch parting strips, and $\frac{5}{8}$ by 2 inch beads. Outside finish as per drawing. The three dark rooms of married soldiers' quarters will have each a window, ordinary size, in partition walls.

SASHES.

Fit to all windows clear white-pine sashes, molded, framed, pinned, and jointed in white lead, not less than $1\frac{3}{4}$ inches thick. Transom sashes same thickness as doors.

BASEMENT WINDOWS.

Set in basement window openings rebated frames of 2-inch white pine. Fit with $1\frac{1}{8}$-inch or $1\frac{1}{4}$-inch sash arranged to swing inwards and fastened with bolts or hooks from outer side. Door for coal chute to be solid, arranged to swing like sash, and secured from outside.

SHEATHING.

The entire frame to be sheathed diagonally with matched hemlock boards. All joints to be cut plumb on a bearing, and boards to be securely nailed, both edges to each bearing. Previous to nailing on clapboards cover the sheathing with Anchor brand tarred paper with 2 inches under lap. No more paper to be put on than can be covered during the day.

ROOFING.

Prepare roof of building, including roof of bell tower, with $\frac{7}{8}$-inch matched hemlock boards not over 6 inches wide, well nailed. Cover the roof with Anchor brand tarred paper, joints well broken and lapped 3 inches.

Cover entire roof, including roof of bell tower, with the Cortright system of metal roofing, or equal, using metal slate 10 by 14 inches. At ridge use the roll ridge coping. The metal roofing to be made of I. C. Melyn or T. B. T. terne. Use the roll ridge manufactured by the Cortright Metal Roofing Company. The ridge to be filled with a wooden core. All metal roof to be securely nailed to sheathing with No. 13 $\frac{7}{8}$-inch steel wire barbed nails, tinned. The small projection at bottom of tower to be shingled with good cypress shingles.

FLASHING.

Flash at all chimneys and at all other places where necessary, using I. X. Melyn or same thickness T. B. T. terne. Valley linings to be used where necessary.

GUTTERS.

Line gutters with I. X. tin of Gilbertson's old method, or equal, painted both sides before brought to the building; run the tin at least 12 inches under the metal slates. Have seams well soldered and strips well cleated to boards. Gutters will have proper slope to leaders.

LEADERS.

Provide and put up three galvanized-iron leaders, well secured to walls with galvanized-iron hooks. Leaders to extend down within 2 feet 6 inches of the ground, to connect with one length of iron pipe which connects with earthen pipe to carry water at least 20 feet from the building.

SIDING.

Cover all walls of building between and over doors and windows with good quality extra clear white pine, beveled siding 6 inches wide, to show not over $4\frac{3}{4}$ inches to the weather. All butt joints leaded as the work progresses.

OUTSIDE FINISH.

Trim windows, doors, corner boards, water table, etc., complete with seasoned, good, sound, white pine, free from large or loose knots, sap, or other imperfections. Water table to be of $1\frac{1}{8}$-inch stuff. All the outside finish planed smooth, true, and square, or molded as shown.

Line the windows and door heads with strips of tin painted twice both sides before being laid. Extend tin 3 inches under clapboards and over the ledge, then nail in front of cap. The roof of piazza, under tower, will be ceiled with best quality of $\frac{3}{4}$ by $2\frac{1}{2}$-inch tongued, grooved, and beaded North Carolina pine.

FLOORS.

On floor beams lay diagonally a 1 by 4 inch rough floor, planed one side to even thickness. For top floors lay $\frac{7}{8}$ by 3 inch seasoned, clear, quarter cut, comb grained North Carolina pine, tongued and grooved, blind nailed to each beam, and all joints to be cut on the beams and smoothed off. Break heading joints. The top floor is not to be laid until the plastering is completed, and when all joiners' work is completed plane off to a dead level. Floor to run through to sheathing and to be carefully framed about studding.

INSIDE WORK.

All the interior finish and exposed wood work of the first and second stories to be of selected clear North Carolina pine, extra kiln dried, free from knots or other imperfections, neatly made, and put up with close joints. All rooms and halls to have molded base, 1 by 8 inches, of same wood as floor. Windows to be trimmed to floor with molded panel back. The room in bell tower will have same finish. Holes will be cut through walls, and thimbles provided where necessary.

DOORS.

Hang to all doorways clear white-pine doors, selected No. 1, free from imperfections of any kind. All doors to have four panels, except large outside door, which will have five flushed moldings, all well glued, wedged, and put together in the best manner. Sash doors as shown. All interior doors to be $1\frac{1}{2}$ inches thick, exterior doors $2\frac{1}{8}$ inches thick, jambs $1\frac{3}{8}$ inches thick, rebated $\frac{1}{2}$ inch to receive the doors. The cellar door to be sash similar to one in day room; architraves 4 inches by $\frac{7}{8}$ inch, molded and finished as shown.

Provide two trap doors, 3 by 4 feet, with hinges, for access to the garret, and also provide suitable ladders. Also provide trap door to bell tower.

The three outside doors of married soldiers' quarters to be sash, and four inside sash doors placed where directed.

SADDLES.

All doors to have molded yellow-pine saddles, 4 inches by $\frac{5}{8}$ inch, and turned striking pins with rubber tips in the base.

PIAZZAS.

The piazzas, stoops, steps, etc., to be built as shown by the drawings. Floor beams 3 by 8 inches, 20 inches from centers. Lay all piazza floors with $1\frac{1}{4}$ by 3 inch yellow pine, well-worked flooring, laid with white lead joints, and blind nailed to each beam. Treads to steps to be $1\frac{1}{2}$ inches thick, risers 1 inch, with 3 by 6 inch horses resting on proper supports in sand. Facias $1\frac{1}{8}$ inch white pine, posts and railing to be

as shown. The main piazza and the kitchen piazza will be finished with rails and posts as shown. All other steps and landings will be built without rails.

STAIRS.

Build one run of stairs from the first to the second story, with open strings facia newels, balusters, and rails complete, of selected kiln dried clear North Carolina pine. Treads and strings $1\frac{3}{8}$ inches thick, molded and return nosings, $\frac{7}{8}$-inch risers. Wedge, glue, house, and block up treads and risers into strings, and support on strong carriage beams, rough bracketed.

Newels, 6 by 6 inches, fancy turned, at foot and head of stairs.
Balusters, 1 by 2 inches, square edged.
Rail, 3 by 4 inches, or equivalent molded.

WAINSCOTING.

The wash and bath room to be wainscoted 5 feet 6 inches high, and the day room and kitchen to be wainscoted 4 feet 6 inches high with best quality seasoned $\frac{3}{4}$ by $2\frac{1}{2}$ inch tongued, grooved, and beaded North Carolina pine, with molded cap.

BATH ROOM.

Make partition in bath room of seasoned North Carolina pine, tongued and grooved, 1 by 3 inches. Make doors in partition of the same material, thoroughly kiln dried, $1\frac{1}{4}$ inches thick, with stationary slats. Hang doors with brass hinges, and furnish strong brass springs for each door, also sliding bolts. Partitions to be 7 feet 6 inches high, including molded cap. Doors to be 5 feet high and 2 feet 6 inches wide. Lower rail of door to be 1 foot from the floor.

WATER TANK.

Place in building at four corners of two main halls four 8 by 8 inch hemlock or spruce timbers, to run through both stories and to be properly framed at top to receive, at some future time, a water tank capable of holding 6,000 gallons. These timbers to rest on proper supports at bottom. Edges to be chamfered near ceiling of first and second story. These timbers will be braced by two crossed pieces of the same size let into each other and properly mortised and pinned to upright pieces, making sixteen pieces in all. Exposed edges to be chamfered.

CELLAR PARTITION.

To be properly framed of 2-inch stuff, and to run from floor to floor to keep out coal dust. Door to be ordinarily framed and braced door with suitable latch.

GLAZING.

Glaze all windows, sash doors, and transoms throughout with good quality American sheet glass, free from waves, specks, or defects. Bed all glazing in putty, using best quality of putty and zinc brads. Clean off glass on arrival at building for inspection before putting up. Make good breakage and leave glass in a perfectly clean condition when work is completed.

HARDWARE.

The contractor shall furnish, fit, and fix securely all necessary hardware for windows, doors, casings, transoms, etc., throughout, of the size required.

Hardware throughout to be of first quality, from first-class manufacturers, and each piece subject to selection and inspection, and shall be provided with proper screws.

All doors will be hung with suitable large loose joint hinges to swing door past rim, and have good mortise locks with brown mineral knobs and keys.

Main entrance door to have flush brass bolts and chain and bronze knobs. The sash generally will be hung with best quality Russian hemp cord over sash pulleys, bronze faced, square grooved wheels not less than $2\frac{1}{2}$ inches diameter, counterbalanced with solid eye cast weight. All transoms to be controlled by transom lifts of approved pattern and make, and have suitable pivots. The lifts will be so placed as to operate transom with ease. The sash fasteners to all windows will be bronze, Hopkins & Dickinson's, or Corbin's, or some other of approved make.

PAINTING.

After wood work is put in place, putty stop smoothly and neatly. Paint all exterior parts of building, such as clapboards, eaves, corner boards, window and door frames, sashes, etc., three coats of best white lead and pure linseed oil, tinted as directed. All interior exposed wood work to be sand papered, and then to have two good coats of pure raw linseed oil. This includes also the ceiling of piazza in front. All rough parts of backs of window frames, casings, jambs, architraves, etc., to be primed with one heavy coat of metallic paint and pure linseed oil. Exposed surface of yellow-pine pulley stile to have two coats of oil, each coat rubbed down. Exposed pipes to be gilded.

PLUMBERS' WORK.

Use entirely heavy galvanized wrought-iron pipe, with heavy galvanized gray iron fittings. At every change of direction place a Y fitting with brass cap for cleaning out.

Carry a line of 2-inch galvanized wrought-iron pipe through brick wall and up through washroom and room above to discharge in tank.

Connect a $1\frac{1}{2}$-inch pipe 3 inches from top of tank, and run to gutter on roof of building.

Place a brass flap-valve on outlet end of pipe to keep out air or cold.

In every case where possible pipes to be free of walls; otherwise they must be put on 1 inch thick stripping.

Carry a line of 2-inch pipe from tank down to washroom, then through floor, and under beams to kitchen.

In washroom, connections will be made for each wash basin and bath tub. The pipes to wash basins will be $\frac{1}{2}$ inch and to bath tubs $\frac{5}{8}$ or $\frac{3}{4}$ inch. In the kitchen, connection will be made with two sinks and hot-water boiler.

From the hot water boiler run a line of $1\frac{1}{2}$-inch pipe under beams to bath rooms, and also make connections in kitchen with two sinks. The tubs and basins will be provided with overflow pipes.

The waste pipes for basins will be $1\frac{1}{2}$ inches and for bath tubs 2

inches. The waste pipe for wash and bath room will be 4-inch pipe carried directly to brick wall, and there to connect with vitrified pipe carried at least 40 feet from building and not less than 3 feet deep.

The waste pipe for kitchen will be 3 inches, carried directly to brick wall, and connection there made with vitrified pipe, carried as above. A Demarest grease trap or equal will be provided for this pipe.

A tell-tale ½-inch pipe will run from tank to kitchen sink.

The present wash basins and bath tubs will be placed in new building and plumbed. The contractor will provide and set up five new basins, sectional slabs and bowl, with patent overflow, brass plug and coupling and stopper, in every way similar and equal to those now in use.

Provide and set up two kitchen sinks with strainer and plugs, 38 by 20 by 6 inches, with legs and back similar to plate 540, G. Mott Iron Works. All cocks to be lever handle of finished brass, with flanges and thimbles, and of Fuller pattern or the equivalent in quality and finish. Make all range and boiler connections in a proper manner, boiler to be furnished by the Government.

GENERAL CLAUSES.

The contractor shall provide and furnish, at his own cost and charge, all transportation, good, sufficient, and safe tools, implements, planking, scaffolding, and appliances of every description necessary or desirable for executing and completing in the best and most thorough manner the several kinds and entire work specified and intended to be done and will prosecute the work without delay, with as many men as can be advantageously employed until the work is completed.

The contractor is not to take advantage of any omission of details in specifications or drawings, but will be required to do everything necessary to complete the work. All materials or work contrary to the spirit of the plans and specifications will be condemned, and must be replaced by the contractor at his own cost, whether built in or not.

The contractor is to protect the building and materials from damage by the weather, and any loss incurred by his negligence must be made good at his own cost.

The contractor will be held responsible for the general care and good order of all the building operations until the acceptance of the work herein specified, and will be required to give all other contractors proper facilities for carrying on their respective work.

The contractor shall employ only competent foremen for the different trades, who are to receive and carry out orders given by the commanding officer in the absence of the contractor.

The commanding officer shall have the power to prescribe the order and manner of executing the work in all its parts and of inspecting and rejecting materials, work, and workmanship which, in his judgment, do not conform to the drawings or specifications. The building is at all times to be kept clear of shavings, rubbish, and waste materials, and must at completion be sound, clean, and perfect, and ready for occupancy. Any extra work must be arranged for in writing at the time of ordering, and an allowance made to the Government for any materials or work called for and not furnished.

APPENDIX 31.

EFFECT OF POSITION OF VENT UPON VELOCITIES AND PRESSURES IN 3.2-INCH B. L. FIELD GUN, STEEL.

UNITED STATES ORDNANCE PROVING GROUND,
Sandy Hook, N. J., August 3, 1891.

SIR: In compliance with instructions contained in your communication of June 27, 1891, I have the honor to forward herewith a table showing the results of a series of firings with the object of ascertaining the effect of change in position of vent from radial to axial position in the 3.2-inch B. L. field gun, steel.

The firings were made with gradually increasing charges and 13½-pound projectile until the pressure of 36,000 pounds was reached, when five rounds were fired with this charge: 3 pounds 5 ounces. This charge not giving a velocity of 1,680 feet, increasing charges were used until the pressure reached about 40,000 pounds with a charge of 3 pounds 8 ounces, the corresponding velocity being 1,581 feet.

The table also contains the results obtained with the radial vent, and similar charges of the same lot of I. K. powder and 13½-pound projectile, showing that with the radial vent the velocities are higher and pressures lower and more uniform than when axial vent is used.

Very respectfully, your obedient servant,

FRANK HEATH,
Captain, Ord. Dept., U. S. Army, Commanding.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

[First indorsement.]

ORDNANCE OFFICE,
Washington, July 9, 1892.

Respectfully returned to the commanding officer Sandy Hook proving ground, with instructions to furnish a similar record of firings with spero-hexagonal powder and axial vent in the 3.2-inch field gun. If the data is not at hand he will make the necessary firings.

D. W. FLAGLER,
Brigadier-General, Chief of Ordnance.

[Second indorsement.]

SANDY HOOK PROVING GROUND,
July 15, 1892.

Respectfully returned to the Chief of Ordnance, U. S. Army, with the record of firings and table of results as called for by preceding indorsement. With the axial vent the pressure of 36,000 pounds per

square inch was not attained; therefore the five rounds required by instructions of June 27, 1891, were not fired.

The charge, 3 pounds 12 ounces, is the greatest that can be used. With the radial vent the charge was carried up to the service weight.

Although with this powder excessive pressures were not developed, as with the I. K. powder, the advantage is with the radial, as uniformly higher velocities are obtained with pressures well within the limits allowed.

FRANK HEATH,
Captain, Ord. Dept., U. S. Army, Commanding.

(5175–'92.)

Table showing comparison between axial and radial vent.

3.2-INCH B. L. RIFLES (STEEL), NOS. 18 AND 26.

[Powder, Du Pont's I. K. H., lot 28.]

Powder weight.	Projectile weight.	Velocity at 125 feet from muzzle.		Pressure per square inch of bore.	
		Axial vent.	Radial vent.	Axial vent.	Radial vent.
Lbs. Oz.	*Lbs. Oz.*	*Feet.*	*Feet.*	*Pounds.*	*Pounds.*
2 8	13 8	1,316	1,328	21,630	19,955
3 0	13 8	1,424	1,465	28,700	27,630
3 4	13 8	1,515	1,553	33,200	29,875
3 5	13 8	1,534	1,546	32,070	32,620
3 5	13 8	1,550	1,550	36,080	32,500
3 5	13 8	1,544	.....	37,000	.....
3 5	13 8	1,550	.....	35,824	.....
3 5	13 8	1,551	.....	37,846	.....
3 5	13 8	1,554	.....	38,800	.....
3 6	13 8	1,579	1,566	37,600	32,540
3 7	13 8	1,586	1,599	41,311	33,660
3 7	13 8	1,593	1,609	38,400	34,000
3 8	13 8	1,581	1,604	39,500	34,355

3.2-INCH B. L. RIFLES (STEEL), NOS. 18 AND 32.

[Powder, Du Pont's sphero-hexagonal U. F., lot 3.]

2 8	13 8	1,342	1,341	18,800	16,660
3 0	13 8	1,491	1,498	24,633	24,967
3 3	13 8	1,537	1,538	26,300	27,400
3 6	13 8	1,590	1,615	28,300	30,246
3 8	13 8	1,623	1,640	29,100	32,105
3 10	13 8	1,656	.....	30,483	.....
3 12	13 8	1,682	.....	32,100	.....

Record of firing with 3.2-inch B. L. rifle (steel), No. 18, West Point

[Object of firing, to determine the effect of axial

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.	Kind.	Weight.				
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Feet.*	*Pounds.*	*Feet.*
June 30	1546		2 8		13 0 8 lead. 13 8	.....	1,316 Lost	No. 4, 21,630	6
June 30	1547		3 0		12 14 10 lead. 13 8	.....	1,422 1,425	No. 4, 28,700	7
June 30	1548		3 4		12 14 10 lead. 13 8	.....	1,513 1,516	No. 4, 33,200	8
June 30	1549		3 8		12 14 10 lead. 13 8	.....	1,581 1,581	No. 4, 39,500	10
June 30	1550		3 5		12 14 10 lead. 13 8	.....	1,534 1,534	No. 4, 32,070	9
P. M. July 27	1551	Du Pont's I. K. H., lot 28; density, 1.725; granulation, 2,442.	2 8	Shell rebanded.	12 6 10 sand. 13 0	8 00	50+$\frac{15}{2}$	.....	.....
July 27	1552		3 6		12 14 10 lead. 13 8	.....	1,581 1,577	No. 4, 37,600	10
A. M. July 28	1553		2 8		12 14 10 lead. 13 8	.....	.....	.....	.....
July 28	1554		3 5		12 14 10 lead. 13 8	.....	1,550 1,549	No. 4, 36,080	10
July 28	1555		3 5		12 14 10 lead. 13 8	.....	1,545 1,543	No. 4, 37,000	10
July 28	1556		3 5		12 12 12 lead. 13 8	.....	1,550 1,549	No. 4, 35,824	10
July 28	1557		3 5		12 12 12 lead. 13 8	.....	1,552 1,550	No. 4, 37,846	10
July 28	1558		3 5		12 14 10 lead. 13 8	.....	1,555 1,552	No. 4, 38,800	10
July 28	1559		3 7		12 12 12 lead. 13 8	.....	1,588 1,583	No. 4, 41,311	11
July 28	1560		3 7		12 8 1 0 lead. 13 8	.....	1,595 1,591	No. 4, 38,400	11

Foundry, at Sandy Hook, N. J., June 30 to July 28, 1891.

position of vent upon velocities and pressures.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Copper cylinder of 18,000 pounds initial compression and tables of 1890. Velocity wires of second target not cut.	
Copper cylinder of 24,000 pounds initial compression and tables of 1887.	
Copper cylinder of 28,000 pounds initial compression and tables of 1887.	Gun mounted on Buffington steel field carriage (light) No. 17. Old spiral-spring brake on right wheel; spiral-spring brake clevis attachment on left wheel. Cannon friction primers, model 1887. Fired into field butt, section 1. Hotchkiss pressure gauge in base of cartridge bag. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
Copper cylinder of 32,000 pounds initial compression and tables of 1890.	
Copper cylinder of 32,000 pounds initial compression and tables of 1890. Spindle of mushroom head broken at first thread.	
Warming charge	
.....	
Warming charge	
.....	
.....	Gun mounted on Buffington steel field carriage (light) No. 17. Bow-spring brake on left wheel; old spiral-spring brake on right wheel. Cannon friction primers, model 1887. Fired to sea. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
.....	
.....	
.....	
.....	
.....	
.....	

Record of firing with 3.2-inch B. L. rifle (steel), No. 18,

[Object of firing, to ascertain velocities and pressures of powder fired in gun

	No. of fire.	Powder.		Projectile.		Depression.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs. Oz.*		*Feet.*	*Pounds.*
A. M.....	1728	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	2 8	Shell, lot 374; band §-inch from base.	13 2 6 sand. 13 8	5	1,342 1,342	No. 4, 18,800
	1729		3 0		13 3 5 sand. 13 8	5	1,493 1,488	No. 4. 24,633
	1730		3 3		13 3 5 sand. 13 8	5	1,539 1,535	No. 4, 26,300
	1731		3 6		13 2 6 sand. 13 8	5	1,591 1,589	No. 4, 28,300
	1732		3 8		13 4 4 sand. 13 8	5	1,625 1,620	No. 4, 29,100
	1733		3 10		13 3 5 sand. 13 8	5	1,658 1,653	No. 4, 30,483
	1734		3 12		13 3 5 sand. 13 8	5	1,683 1,680	No. 4, 32,100
							$50 + \frac{150}{2}$	

West Point Foundry, at Sandy Hook, N. J., July 13, 1892.

with axial vent in comparison with same charges fired in guns with radial vent.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.	From front, 8 miles an hour.		Gun mounted on Buffington steel field carriage No. 5. Bow-spring brakes. Cannon friction primers, model 1887; Frankford Arsenal, January, 1891. Fired into field butt, No. 2. Copper cylinders of 28,000 pounds initial compression and tables of 1890 used in rounds 1731 to 1734, inclusive. Breechblock having axial vent fitted to gun before this firing. Radial vent closed with spelter. Barometer, 30.06; thermometer, 87°; humidity, 57. Velocities and pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
5½		Copper cylinders of 9,000 pounds initial compression and tables of 1890.	
7		Copper cylinder of 24,000 pounds initial compression and tables of 1890.	
10		Copper cylinder of 24,000 pounds initial compression and tables of 1890.	
12		.....	
13		.....	
14		.....	
15		Cartridge entered chamber with slight difficulty.	

Record of firing with 3.2-inch B. L. rifle (steel), No. 32,

[Object of firing, to ascertain velocities and pressures of powder fired in gun

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Depression.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*	′	*Feet.*	*Pounds.*
P. M	161	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	2 8	Shell, lot 371; band ⅝-inch from base.	13 0 8 sand. 13 8	5	1,341 1,340	No. 3, 16, 660
	162		3 0		13 3 5 sand. 13 8	5	1,504 1,492	No. 3, 24, 967
	163		3 3		13 3 5 sand. 13 8	5	1,544 1,532	No. 3, 27, 400
	164		3 6		13 0 8 sand. 13 8	5	1,617 1,612	No. 3, 30, 246
	165		3 8		13 0 8 sand. 13 8	5	1,644 1,636	No. 3, 32, 105
							50+$\frac{15}{2}$°	

Watervleit Arsenal, at Sandy Hook, N. J., July 14, 1892.

with axial vent in comparison with same charges fired in gun with radial vent.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.	From front, 9 miles an hour.		
6		Copper cylinder of 9,000 pounds initial compression and tables of 1890.	
8		Copper cylinder of 18,000 pounds initial compression and tables of 1890.	Gun mounted on Buffington steel field carriage No. 17. Bow-spring brakes. Cannon friction primers, model, 1887; Frankford Arsenal, January, 1891. Fired into field butt, No. 2. Gun having radial vent used. Barometer, 30.10; thermometer, 76°; humidity, 82. Velocities and pressure taken by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department.
9½		Copper cylinder of 24,000 pounds initial compression and tables of 1890.	
10		Copper cylinder of 28,000 pounds initial compression and tables of 1890.	
12		Copper cylinder of 28,000 pounds initial compression and tables of 1890.	

Record of firing with 3.2-inch B. L. rifle (steel), No. 26,

[Object of firing, to determine

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Feet.*	*Pounds.*
P. M. July 27	317	DuPont's I.K.H., lot 28.	2 8		12 14 2 sand. 13 0	8 00	.....	.....
July 27	318	DuPont's I.K.H., lot 27; density, 1.725; granulation, 2,605.	3 8		12 14 10 lead. 13 8	0 00	1,607 1,605	No. 3, 33,400
July 27	319		3 12		12 15 9 lead. 13 8	0 00	1,670 1,668	No. 3, 37,000
July 27	320		3 12		12 14 10 lead. 13 8	0 00	1,704 1,702	No. 3, 44,155
July 27	321		3 8		13 0 8 lead. 13 8	0 00	1,607 1,601	No. 3, 34,355
July 27	322		3 10		12 14 10 lead. 13 8	0 00	1,645 1,636	No. 3, 35,870
July 27	323		3 12		12 14 10 lead. 13 8	0 00	1,681 1,682	No. 3, 38,280
July 27	324		3 12		12 11 13 lead. 13 8	0 00	1,674 1,677	No. 3, 38,000
July 27	325	Du Pont's I. K. H., lot 29; density, 1.725; granulation, 2,405.	3 10		12 14 10 lead. 13 8	0 00	1,633 1,636	No. 3, 34,866
July 27	326		3 12		12 14 10 lead. 13 8	0 00	1,658 1,657	No. 3, 36,060
July 27	327		3 12		12 11 13 lead. 13 8	0 00	1,664 1,666	No. 3, 36,060

Du Pont's I. K. H., lot 28; density, 1.725; granulation, 2,442.

Shell rebanded.

Watervliet Arsenal, at Sandy Hook, N. J., July 27, 1891.

velocities and pressures.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
.....	From rear, 9 miles an hour.	Warming charge	
10		.....	
12		.....	
11		Pressure abnormal; powder crushed in forcing breechblock home.	
11		.....	Gun mounted on Buffington steel field carriage (light) No. 17. Bow-spring brake on left wheel; old spiral-spring brake on right wheel. Cannon friction primers, model 1887. Fired to sea. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
10		.....	
11		.....	
11		.....	
10		.....	
11		.....	

Record of firing with 3.2-inch B. L. rifle (steel), No. 26,

[Object of firing, to obtain

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Feet.*	*Pounds.*
A. M. July 30	328	Du Pont's I.K.H., lot 28.	3 8		12 14 2 sand. 13 0	.....	.....	.....
July 30	329	Du Pont's I.K.H., lot 27; density, 1.725; granulation, 2,605.	3 10		12 14 10 lead. 13 8	0 00	Lost.	No. 4, 34, 260
July 30	330		3 10		12 12 12 lead. 13 8	00 0	1,615 1,611	No. 4, 35, 600
July 30	331		3 11		12 12 12 lead. 13 8	0 00	1,637 Lost.	No. 4, 35, 945
July 30	332		3 11		12 13 11 lead. 13 8	0 00	1,633 1,634	No. 4, 36, 020
July 30	333		3 11		12 14 10 lead. 13 8	0 00	1,639 1,635	No. 4, 36, 240
July 30	334	Du Pont's I. K. H., lot 28; density, 1.725; granulation, 2,442.	3 11		12 12 12 lead. 13 8	0 00	1,651 Lost.	No. 4, 37, 110
July 30	335		3 11		12 15 9 lead. 13 8	0 00	1,646 1,639	No. 4, 36, 845
July 30	336	Du Pont's I.K.H., lot 29; density, 1.725; granulation, 2,605.	3 11		12 14 10 lead. 13 8	0 00	1,637 1,631	No. 4, 36, 040
July 30	337		3 11		12 15 9 lead. 13 8	0 00	1,636 1,627	No. 4, 35, 680
							$50+\frac{150}{2}$	

Watervliet Arsenal, at Sandy Hook, N. J., July 30, 1891.

velocities and pressures.]

Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.	Warming charge	Gun mounted on Buffington steel field carriage (light) No. 17. Bow-spring brake on left wheel; old spiral-spring brake on right wheel. Cannon friction primers, model 1887. Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1890.
10		
10		
11		
11		
11		
11		
11		
11		
11		
11		

Record of firing with 3.2-inch B. L. rifle (steel), No. 26,

[Object of firing, to obtain velocities and pressures for

	No. of fire.	Powder.		Projectile.		Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs. Oz.*	*Feet.*	*Pounds.*	*Feet.*
P. M.....	338	Du Pont's I. K. H., lot 28; density, 1.725; granulation, 2,442.	3 8	Shell rebanded.	12 15 11 sand. 13 10			
	339		2 8		12 14 10 sand. 13 8	1,332 1,324	No. 4, 19, 955	9
	340		3 0		12 15 9 lead. 13 8	1,469 1,460	No. 4, 27, 630	10
	341		3 4		12 12 12 lead. 13 8	1,558 1,548	No. 4, 29, 875	11
	342		3 5		12 11 13 lead. 13 8	1,548 1,543	No. 4, 32, 620	11
	343		3 5		12 11 13 lead. 13 8	1,554 1,546	No. 4, 32, 500	11
	344		3 6		12 11 13 lead. 13 8	1,569 1,563	No. 4, 32, 540	11
	345		3 7		12 14 13 lead. 13 8	1,601 1,596	No. 4, 33, 660	11
	346		3 7		12 14 10 lead. 13 8	1,611 1,608	No. 4, 34, 000	12
						$50 \times \frac{150}{2}$		

Watervliet Arsenal, at Sandy Hook, N. J., July 30, 1891.

comparison with results obtained with axial vent.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Warming charge	Cannon friction primers, model 1887. Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 341 to 346, inclusive. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
Copper cylinders of 18,000 pounds initial compression and tables of 1890.	
Copper cylinders of 24,000 pounds initial compression and tables of 1887.	
.....	
.....	
.....	
.....	
.....	
.....	
.....	

APPENDIX 32.

REPORT OF TRIAL OF EQUIPMENT FOR 3.6-INCH B. L. FIELD MORTAR (STEEL).

(6 plates.)

SANDY HOOK PROVING GROUND,
January 28, 1892.

SIR: In compliance with your instructions of September 17, 1891, I have the honor to forward herewith record of test of an equipment for the 3.6-inch B. L. field mortar. This equipment, consisting of one wooden platform, with pintle block, eight stakes, one anchor stake, two handspikes, and one pointing scale, is shown in drawing from your office dated July 10, 1891.

The platform consists of two side pieces of 3-inch oak (or yellow pine), into which are framed and secured by wooden pins eleven cross pieces of same material. These cross pieces are secured to each other by wooden dowels. A 4 by 3 inch piece is bolted to the rear cross piece by three bolts. The pintle block of cast iron is fastened to the front of platform by four wrought-iron bolts. A pintle fork attached to the carriage embraces the pintle, forming the center of motion for the traversing of the carriage. The platform is held in position by eight stakes, same as for siege mortar platforms, two on each side, two in rear, and two in front, the latter passing through square wrought-iron rings attached to eye pieces, the latter being bolted to front end of platform. At a suitable point in the axis of the platform is placed a brass socket, in which works the brass pivot at the end of the pointing scale.

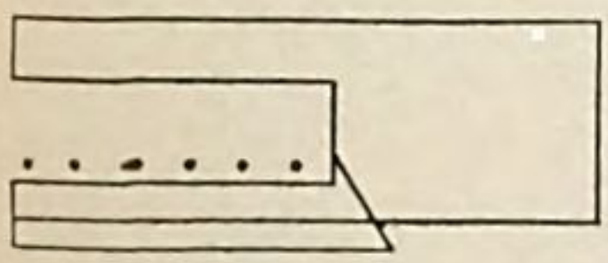
The anchor stake is 4 inches in diameter and 48 inches long, the outer end being strengthened by an iron band. Around this stake is wound the middle portion of the restraining rope, which is held in place on the stake by two pins passing through the stake perpendicular to its axis. The ends of the rope are fastened to two rings, one on each cheek of carriage. The rope is given sufficient slack to allow any desired free recoil of the carriage, usually about 5 feet.

The pointing scale is of hard wood, graduated on one side, the unit of the scale being one one-thousandth of the range, and each division one five-hundredth of the range. A brass index slide moves with friction along the length of the scale, and clamped by a screw when regulated. For reference marks a brass screw is placed at the end of each cheek of carriage, and the scale is so arranged that it can be applied to either cheek desired. The carriage admits of a motion around its pintle of about 15° on either side of the axis of the platform. The object of the test was to ascertain the strength of the different parts of the equip-

ment, the stability of the platform, and the accuracy and utility of the pointing scale.

To test the strength and stability of the system fifty rounds were fired, full charges being used except with the first round. Considerable difficulty was at first encountered in planting the anchor stake sufficiently firmly to prevent its being pulled out after carriage had recoiled the extent permitted by the restraining rope. The sandy soil at this place presented the most unfavorable conditions that would probably be met with in actual service. This difficulty was overcome by placing the stake in a hole dug for the purpose, surrounding it with pieces of board and tamping the whole firmly with sand. In ordinary earth the simple driving in of the stake would be sufficient.

At about the eighth round the cross pieces of the platform began to show a depression on the left side below the surface of the side pieces. On examination it was found that the under surfaces of side pieces, especially on left side, were split, and this had caused the lower portion of the side pieces in the vicinity of the mortar to give way thus—



and so permitting the depression of cross pieces as described. It is therefore evident that the mortising of the side pieces seriously weakens them. This defect could be remedied by substituting $\frac{3}{4}$-inch bolts for the wooden pins which hold the cross to the side pieces, or, instead of mortising out the middle portion of the side piece, the mortise might be placed higher, so as to leave, say, 0.375 inch stock above and 1.375 inches below, instead of 0.875 inch on both sides, as is now done. This would strengthen the lower portion of the side piece, where the greatest strength is required.

A 3-inch restraining rope used double was found to be much more serviceable than a single rope of larger dimensions. It was also found convenient to pass a $\frac{3}{4}$-inch iron bar through the rings to which the rope was attached, rather than to the rings themselves. A stout toggle forged to the ring might answer the same purpose.

To test the accuracy and utility of the pointing scale the mortar (using 5-ounce charge and 45° elevation) was sighted by the latter at the center of the 1,000-yards target, and the corresponding position of the ○ of sliding index was at the division of 274.5 on the scale. In the subsequent four rounds the mortar was brought to the same position by means of the scale. The lateral dispersion by this method of pointing was 4 yards. This, as well as the other lateral dispersions resulting from this method, compare very favorably with any results heretofore obtained with this mortar under similar conditions of loading. At the second target at 1,000 yards the mortar was pointed 15 yards to left of center by setting the index at 259.5 of the scale, and the center of impact of the five shots was found to be 15.6 yards to the left of that obtained when pointing at the center. At the third target the mortar was pointed 10 yards to the right of center, the index being set at 284.5; the center of impact of these shots was 5.4 yards to the right of that obtained when pointing at center. Similar firings were conducted using 8-ounce charges and 15° elevation. The lateral dispersions were 4 yards, 1.4 yards, and 2 yards, respectively, and the center of impact of second five shots was 13.8 yards to the left, and of the third 7.2 yards to the right of that obtained with first five rounds aimed directly at center of target. The results of these tests indicate that this equipment as a whole is simple, serviceable, and well adapted for the purposes intended. It is believed that none of the parts can with advantage be dispensed with. The pointing scale is easily manipu-

lated, and may be relied upon to work practically within the limits of lateral dispersion corresponding to the elevation and charges used.

Very respectfully, your obedient servant,

FRANK HEATH,
Captain, Ord. Dept., U. S. Army, Commanding.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

(582–'92.)

Record of firing with 3.6-inch B. L. field mortar (steel), No. 1, Watervliet

[Object of firing, to

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Recoil.	Wind, strength and direction.
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	°	*Feet.*	
Oct. 6	726	Du Pont's I. K. H., lot 4; density, 1.725; granulation, 2,071.	0 3	Shell (banded), experimental lot 326.	19 0 1 0 sand. 20 0	15	2.9	10 miles an hour.
Oct. 6	727		1 0		18 13 1 3 sand. 20 0	15	9	
Oct. 6	728		1 0		18 15 1 1 sand. 20 0	15	20	
Oct. 6	729		1 0		18 13 1 3 sand. 20 0	15	12	
Oct. 6	730		1 0		18 12 1 4 sand. 20 0	15	12	
Oct. 6	731		1 0		18 12 1 4 sand. 20 0	15	11	
Oct. 6	732		1 0		18 15 1 1 sand. 20 0	15	8	
Oct. 6	733		1 0		19 1 15 sand. 20 0	15	8	
Oct. 6	734		1 0		19 0 1 0 sand. 20 0	15	9	
Oct. 6	735		1 0		18 12 1 4 sand. 20 0	15	9	

[Object of firing, exhibition of

Nov. 19	736	Du Pont's I.K. H., lot 4; density, 1.725; granulation, 2,071.	1 0	Shell, lot 326.	18 14 1 2 sand. 20 0	30	9	From rear 30° left, 9 miles an hour.

Arsenal, at Sandy Hook, N. J., October 6 and November 19, 1891.

test mortar platform.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Anchor stake driven vertically into the sand in front of platform. Rope allows recoil of 6 feet.	
Anchor stake pulled out by recoil. Rope allows recoil of 6 feet.	
Anchor stake driven in inclined position, head to the rear. Rope pulled off stake. Rope allows recoil of 6 feet.	
One turn of rope taken around stake. Rope allows recoil of 5 feet. Stake pulled out by recoil. Vent shield bent.	Mortar mounted on experimental steel carriage made at Watervliet Arsenal. Cannon friction primers, model 1887. Fired from new wooden platform made at Watervliet Arsenal. Pintle fork attached to front plate of carriage. Fired down the beach. New vent shield put on. Lower arm lengthened so as to extend over lower stops when vent is closed. Recoil restrained by worn 2½-inch rope. Platform has an inclination to rear of 3°. Mortar recoils full length of rope, stretching it, and is drawn back about 2 feet towards firing position. Rope allows recoil of 9 feet. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
Stake driven in as in last round. Stake pulled out by recoil. Rope allows recoil of 6 feet.	
Stake driven in inclined position, head to the front. One turn of rope taken around stake. Stake pulled out by recoil. Rope allows recoil of 6 feet.	
Trench dug in front of platform. Anchor stake set in with boards in front and rear. Sand well tamped about boards and stake. Rope broke. Rope allows recoil of 6 feet.	
Recoil restrained by new 3-inch rope. Two turns taken about stake. Cross pieces of platform show depression on left side below surface of side timber. Front edge of one of the rear cross pieces worn by carriage in recoiling. Recoil restrained by new 3-inch rope. Two turns taken about stake.	
Recoil restrained by new 3-inch rope. Two turns taken about stake. Anchor stake loosened in place by last three rounds. Split found in under surface of left side piece of platform.	

piece before the Chief of Ordnance.]

Two primers failed, being partially pulled out of vent and then broken by the pull on lanyard.	Mortar mounted on experimental steel carriage, Cannon friction primers, model 1887. Fired to sea. Recoil restrained by 3-inch rope, allowing recoil of 9 feet. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.

Record of firing with 3.6-inch B. L. mortar (steel), No. 1,

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Including sand.	Elevation.
		Kind.	Weight.	Kind.	Weight.		
A. M.			*Lbs.*		*Lbs.*	*Lbs. Oz.*	°
Dec. 28	737	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	1	Shell, lot 326.	20	1 3	45
Dec. 31	738		1		20	1 4	45
Dec. 31	739		1		20	1 2	45
Dec. 31	740		1		20	1 2	45
Dec. 31	741		1		20	1 1	45
Dec. 31	742		1		20	1 1	45
Dec. 31	743		1		20	14	45
Dec. 31	744		1		20	1 4	45
Dec. 31	745		1		20	1 0	45
Dec. 31	746		1		20	15	45
Dec. 31	747		1		20	1 2	45
Dec. 31	748		1		20	1 0	45
Dec. 31	749		1		20	1 1	45
Dec. 31	750		1		20	1 2	45
Dec. 31	751		1		20	1 1	45
Dec. 31	752		1		20	1 1	45
Dec. 31	753		1		20	1 0	45
Dec, 31	754		1		20	1 1	45
Dec. 31	755		1		20	1 0	45
Dec. 31	756		1		20	1 3	45
Dec. 31	757		1		20	1 2	45
Dec. 31	758		1		20	1 0	45
Dec. 31	759		1		20	1 2	45
Dec. 31	760		1		20	1 0	45
Dec. 31	761		1		20	1 0	45
Dec. 31	762		1		20	1 0	45
Dec. 21	763		1		20	1 1	45
Dec. 31	764		1		20	1 5	45
Dec. 31	765		1		20	1 3	45
Dec. 31	766		1		20	1 0	45
Dec. 31	767		1		20	15	45
Dec. 31	768		1		20	1 0	45
Dec. 31	769		1		20	1 0	45
Dec. 31	770		1		20	1 1	45
Dec. 31	771		1		20	1 0	45
Dec. 31	772		1		20	15	45
Dec. 31	773		1		20	1 3	45
Dec. 31	774		1		20	1 2	45
Dec. 31	775		1		20	1 2	45

Watervliet Arsenal, at Sandy Hook, N. J., December 28 and 31, 1891.

to test platform.

Special remarks about each fire, such as effect on piece, action of breech mechanism. consumption of powder, sound ofprojectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
.....	
.....	
Joint between left side piece of platform and cross plank, opening.	
.....	
Mortar pointed to left.....	
.....	
Mortar pointed to right.....	
.....	
Mortar pointed to left.....	
.....	
.....	
.....	Mortar mounted on experimental steel carriage.
.....	Cannon friction primers, model 1887.
.....	Before this firing it was noticed that both side pieces of platform were cracked on under sides.
Mortar pointed to left.....	
First primer failed.....	Charge in bag too large for chamber. Powder emptied from bag loose in chamber.
.....	
.....	Fired to sea.
.....	Platform placed in new position. Stakes so much damaged by driving as to render them unfit for further use.
First primer failed.....	
Mortar pointed to left.....	
Mortar pointed to left.....	This is the third setting of platform.
.....	Rope allows recoil of 1 foot 9 inches.
.....	Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
.....	
Anchor stake slightly displaced by recoil.....	
.....	
.....	
.....	
.....	
.....	
.....	
.....	
.....	
.....	

Record of firing with 3.6-inch B. L. field mortar (steel), No. 1,

[Object of firing, to test efficiency

	No. of fire.	Powder.		Projectile.		Elevation.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.			
			Oz.		*Lbs. Oz.*	°	*Ft. In.*	
A. M	776	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	5	Shell, lot 326.	18 15 1 1 sand. 20 0	45	1 0	Right and rear 10°, 9 miles an hour.
	777		5		18 14 1 2 sand. 20 0	45	1 0	
	778		5		18 13 1 3 sand. 20 0	45	1 0	
	779		5		18 13 1 3 sand. 20 0	45	1 1	
	780		5		18 12 1 4 sand. 20 0	45	1 0	

Watervliet Arsenal, at Sandy Hook, N. J., January 5, 1892.

of pointing scale and platform.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
.....	
.....	Mortar mounted on experimental steel carriage. Cannon friction primers, model 1887. Mortar sighted by pointing scale at center of 1,000-yards target, using index on left cheek of carriage. Sliding index of pointing scale set at 274.5.
.....	
.....	

TARGET.

No. of round.	Range.	Lateral deviation from plane of fire, right	From center of impact, longitudinal.		From center of impact, lateral.	
			+	−	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*
776	939	20	.....	16.6	2.4	.....
777	903	16	.....	52.6	.....	1.6
778	956	18	0.4	.....	0.4	.....
779	985	17	29.4	.....	.....	0.6
780	995	17	39.4	.....	.....	0.6
	4,778	88	69.2	69.2	2.8	2.8

4,778÷5=955.6 88÷5=17.6 138.4÷5=27.68 5.6÷5=1.12

	Yards.
Greatest range	995
Least range	903
Dispersion in range	92
Greatest deviation from plane of fire	20
Least deviation from plane of fire	16
Lateral dispersion	**4**

	Yards.
Mean range	955.6
Mean lateral deviation from plane of fire ..... right..	17.6
Mean longitudinal deviation from center of impact	27.68
Mean lateral deviation from center of impact	1.12

Record of firing with 3.6-inch B. L. field mortar (steel), No. 1,

[Object of firing, to test efficiency

	No. of fire.	Powder.		Projectile.		Elevation.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.			
			Oz.		*Lbs. Oz.*	°	*Ft. In.*	
A. M	781	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	5	Shell, lot 326.	18 13 1 3 sand. 20 0	45	1 1	Right and rear 9°, 9 miles an hour.
	782		5		18 10 1 6 sand. 20 0	45	1 2	
	783		5		19 0 1 0 sand. 20 0	45	1 1	
	784		5		18 14 1 2 sand. 20 0	45	1 1	
	785		5		18 12 1 4 sand. 20 0	45	1 0	

Watervliet Arsenal, at Sandy Hook, N. J., January 5, 1892—Continued.

of pointing scale and platform.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	Cannon friction primers, model 1887.
.....	Mortar sighted by pointing scale 15 yards to left of center of 1,000-yards target, using index on left cheek of carriage
.....	Sliding index of pointing scale set at 259.5.
.....	

TARGET.

No. of round.	Range.	Lateral deviation from plane of fire, right.	From center of impact, longitudinal.		From center of impact, lateral.	
			+	−	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*
781	953	16.25	.....	4.8	.....	0.05
782	978	15.50	20.2	.....	.....	0.80
783	982	14.50	24.2	.....	.....	1.80
784	928	17.00	.....	29.8	0.70	.....
785	948	18.25	.....	9.8	1.95	.....
	4,789	81.50	44.4	44.4	2.65	2.65

4,789÷5=957.8 81.50÷5=16.30 88.8÷5=17.76 5.30÷5=1.06

	Yards.
Greatest range	982
Least range	928
Dispersion in range	54
Greatest deviation from plane of fire	18.25
Least deviation from plane of fire	14.50
Lateral dispersion	3.75

	Yards.
Mean range	957.8
Mean lateral deviation from plane of fire ..... right..	16.30
Mean longitudinal deviation from center of impact	17.76
Mean lateral deviation from center of impact	1.06

Center of impact, 15.6 yards left of center of impact of target; rounds, 776 to 780, inclusive.

Record of firing with 3 6-inch B. L. field mortar (steel), No. 1,

[Object of firing, to test efficiency

	No. of fire.	Powder.		Projectile.		Elevation.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.			
			Oz.		*Lbs. Oz.*	°	*Ft. In.*	
A. M	786	Du Pont's sphero hexagonal U. F., lot 3; density, 1.700; granulation, 123.	5	Shell, lot 326.	19 0 1 0 sand. 20 0	45	1 0	Right and rear 10½°, 9 miles an hour.
	787		5		18 13 1 3 sand. 20 0	45	1 0	
	788		5		18 12 1 4 sand. 20 0	45	1 2	
	789		5		18 14 1 2 sand. 20 0	45	.....	
	790		5		18 13 1 3 sand. 20 0	45	3 0	

Watervliet Arsenal, at Sandy Hook, N. J., January 5, 1892—Continued.

of pointing scale and platform.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
.....	
.....	Cannon friction primers, model 1887.
.....	Mortar sighted by pointing scale 10 yards to the right of center of 1,000-yards target, using index on left cheek of carriage.
.....	Sliding index of pointing scale set at 284.5.
.....	

TARGET

No. of round	Range.	Lateral deviation from plane of fire, right.	From center of impact, longitudinal.		From center of impact, lateral.	
			+	−	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*		
786	970	15.3	.....	20	2.21	.....
787	970	13.3	.....	20	.21	.....
788	988	12.1	.....	2	.....	0 99
789	1,025	13.75	35	.....	.66	.....
790	997	11.00	7	.....	.....	2.09
	4,950	65.45	42	42	3.08	3.08

4,950÷5=990 64.45÷5=13.09 84÷5=16.8 6.16÷5=1.232

	Yards.
Greatest range	1,025
Least range	970
Dispersion in range	55
Greatest deviation from plane of fire	15.3
Least deviation from plane of fire	11
Lateral dispersion	4.3

	Yards.
Mean range	990
Mean lateral deviation from plane of fire ..... right..	13.09
Mean longitudinal deviation from center of impact	16.8
Mean lateral deviation from center of impact	1.232

Center of impact, 5.4 yards right of center of impact of target; rounds, 776 to 780.

Record of firing with 3.6-inch B. L. field mortar (steel), No. 1,

[Object of firing, to test efficiency

	No. of fire.	Powder.		Projectile.		Elevation.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.			
			Oz.		*Lbs. Oz.*	°	*Ft. In.*	
A. M.....	791	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	8	Shell, lot 326.	18 14 1 2 sand. 20 0	15	3 0	Right and rear 10°, 9 miles an hour.
	792		8		18 13 1 3 sand. 20 0	15	3 2	
	793		8		18 13 1 3 sand. 20 0	15	3 2	
	794		8		18 14 1 2 sand. 20 0	15	2 10	
	795		8		18 14 1 2 sand. 20 0	15	2 10	

Watervliet Arsenal, at Sandy Hook, N. J., January 5, 1892—Continued.

of pointing scale and platform.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	Cannon friction primers, model 1887. Mortar sighted by pointing scale at center of 1,000-yards target, using index on left cheek of carriage. Sliding index of pointing scale set at 274.5.

TARGET.

No. of round.	Range.	Mean lateral deviation from plane of fire, right.	From center of impact, longitudinal.		From center of impact, lateral.	
			+	−	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*
791	926	1	10.4	.....	.....	1
792	892	0	.....	23.6	.....	2
793	942	2	26.4	.....	0	0
794	882	3	.....	33.6	1	.....
795	936	4	20.4	.....	2	.....
	4,578	10	57.2	57.2	3	3

4,578÷5=915.6 10÷5=2 114.4÷5=22.88 6÷5=1.2

	Yards.
Greatest range	942
Least range	882
Dispersion in range	60
Geatest deviation from plane of fire	4
Least deviation from plane of fire	0
Lateral dispersion	4

	Yards.
Mean range	915.6
Mean lateral deviation from plane of fire.....right	2
Mean longitudinal deviation from center of impact	22.88
Mean lateral deviation from center of impact	1.2

Record of firing with 3.6-inch B. L. field mortar (steel), No. 1,

[Object of firing, to test efficiency

	No. of fire.	Powder.		Projectile.		Elevation.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.			
			Oz.		*Lbs. Oz.*	°	*Ft. In.*	
A. M.	796	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	8	Shell, lot 326.	20 0	15	3 00	Right and rear 9°, 9 miles an hour.
	797		8		18 15 1 1 sand. 20 0	15	2 10	
	798		8		18 14 1 2 sand. 20 0	15	2 10	
	799		8		18 14 1 2 sand. 20 0	15	2 10	
	800		8		18 15 1 1 sand. 20 0	15	2 10	

Watervliet Arsenal, at Sandy Hook, N. J., January 5, 1892—Continued.

of pointing scale and platform.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
.....	
.....	
.....	
.....	Cannon friction primers, model 1887. Mortar sighted by pointing scale 15 yards to the left of center of 1,000-yards target, using index on left cheek of carriage. Sliding index of pointing scale set at 259.5.
.....	
.....	

TARGET.

No. of round.	Range.	Lateral deviation from plane of fire, left.	From center of impact, longitudinal.		From center of impact, lateral.	
			+	—	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*
796	918	2.8	4.8	.....	.....	0.86
797	958	1.4	44.8	.....	0.54	.....
798	882	2.2	.....	31.2	.....	0.26
799	916	1.8	2.8	.....	0.14	.....
800	892	1.5	.....	21.2	0.44	.....
	4,566	9.7	52.4	52.4	1.12	1.12
	4,566÷5=913.2	9.7÷5=1.94	104.8÷5=20.96		2.24÷5=0.448	

	Yards.
Greatest range	958
Least range	882
Dispersion in range	76
Greatest deviation from plane of fire	2.8
Least deviation from plane of fire	1.4
Lateral dispersion	1.4

	Yards.
Mean range	913.2
Mean lateral deviation from plane of fire ..... left..	1.94
Mean longitudinal deviation from center of impact	20.96
Mean lateral deviation from center of impact	0.448

Center of impact, 13.8 yards left of center of impact of target; rounds, 791 to 795, inclusive.

Record of firing with 3.6-inch B. L. field mortar (steel), No. 1,

[Object of firing, to test efficiency

	No. of fire.	Powder.		Projectile.		Elevation.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.			
			Oz.		*Lbs. Oz.*	°	*Ft. In.*	
A. M.....	801	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	8	Shell, lot 326.	20 0	15	3 00	Right and rear 10¼°, 9 miles an hour.
	802		8		20 0	15	3 00	
	803		8		18 14 1 2 sand. 20 0	15	2 11	
	804		8		18 12 1 4 sand. 20 0	15	2 11	
	805		8		18 13 1 3 sand. 20 0	15	.....	

Watervliet Arsenal, at Sandy Hook, N. J., January 5, 1892—Continued.

of pointing scale and platform.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
Anchor stake displaced by recoil	
.....	Cannon friction primers, model 1887.
	Mortar sighted by pointing scale 10 yards to the right of center of 1,000-yards target, using index on left cheek of carriage.
.....	Sliding index of pointing scale set at 284.5.
	Mortar sighted by Lieut. O. M. Lissak, Ordnance Department.
	Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
.....	

TARGET.

No. of round.	Range.	Lateral deviation from plane of fire.		From center of impact, longitudinal.		From center of impact, lateral.	
		Right.	Left.	+	—	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards*
801	908	0	0	.....	5	.....	0.2
802	921	1	.....	8	.....	0.8	.....
803	903	.....	1	.....	10	.....	1.2
804	909	0	0	.....	4	.....	0.2
805	924	1	.....	11	.....	0.8	.....
	4,565	2	1	19	19	1.6	1.6

4,565÷5=913 2—1=1÷5=0.2 38÷5=7.6 3.2÷5=0.64

	Yards.		Yards.
Greatest range	924	Mean range	913
Least range	903	Mean lateral deviation from plane of fire.....right..	0.2
Dispersion in range	21	Mean longitudinal deviation from center of impact	7.6
Greatest deviation from plane of fire, right.	1	Mean lateral deviation from center of impact	0.64
Greatest deviation from plane of fire, left ..	1		
Lateral dispersion	2		

Center of impact, 7.2 yards right of center of impact of target; rounds, 791 to 795, inclusive.

Record of firing with 3.6-inch B. L. field mortar (steel), No. 1,

[Object of firing,

	No. of fire.	Powder.		Projectile.		Elevation.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.			
			Oz.		*Lbs. Oz.*	°	*Feet.*	
A. M	806	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	10	Shell, lot 351.	18 14 1 2 sand. 20 0	45	5	From right, 6 miles an hour.
	807		10		18 15 1 1 sand. 20 0	45	3½	
	808		10		18 15 1 1 sand. 20 0	45	3½	
	809		10		19 1 15 sand. 20 0	45	3½	

Watervliet Arsenal, at Sandy Hook, N. J., June 18, 1892.

to obtain range.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Shot lost	Gun mounted on experimental steel carriage. Recoil restrained by 2½-inch rope, doubled. Direction given by strips nailed on platform. Toggles fitted to mortar carriage, replacing rings for recoil ropes. Fired down the beach. Aimed so that shot would fall in sea. Barometer, 30.39; thermometer, 63°; humidity, 95. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
Rope allows recoil of 3½ feet. Shot lost	
Shot lost	
Shot lost	

Record of firing with 3.6-inch B. L. field mortar (steel),

[Object of firing, to determine range with different

Date.	No. of fire.	Powder.		Projectile.		Including sand.	Elevation.	Range.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.					
A. M.			*Lbs. Oz.*		*Lbs.*	*Lbs. Oz.*	°	*Yards.*		
June 28	810	Du Pont's I. K. H., lot 29; density, 1.725; granulation, 2,405.	1 0	Shell, lot 351.	20	1 14	45	3,429	Greatest variation, 223 yards.	
June 28	811		1 0		20	15	45	3,346		
June 28	812		1 0		20	1 3	45	Lost.		
P. M.										
June 28	813		1 0		20	1 3	45	Lost.		
June 28	814		1 0		20	15	45	3,439		
June 28	815		1 0		20	15	45	3,569		
June 28	816	Du Pont's F., lot 3; density, 1.700; granulation, 123.	15		20	1 4	45	3,279	Greatest variation, 166 yards.	
June 28	817		15		20	1 4	45	3,304		
June 28	818		15		20	1 4	45	3,266		
June 28	819		15		20	15	45	3,217		
June 28	820		15		20	1 4	45	3,383		
June 28	821		15		20	1 3	45	3,308		
A. M.										
June 29	822	Du Pont's sphero-hexagonal U. F., density, 1.700; granulation, 123.	11	Shell, lot 351.	20	15	45	Lost.	Greatest variation, 186 yards.	June 28, from right and rear, 12 miles an hour; June 29, from right 90°, 6 miles an hour; from right, 6 miles an hour.
June 29	823		11		20	15	45	Lost.		
June 29	824		11		20	15	45	Lost.		
June 29	825		11		20	15	45	2,427		
June 29	826		11		20	1 4	45	Lost.		
June 29	827		11		20	15	45	2,337		
June 29	828		11		20	1 4	45	2,241		
June 29	829		11		20	1 4	45	2,377		
P. M.										
June 29	830		11		20	1 4	45	2,310		
June 29	831		11		20	15	45	2,309	Greatest variation, 139 yards.	
June 29	832		11		20	15	45	Lost.		
June 29	833		11		20	15	45	2,246		
June 29	834		11		20	15	45	2,383		
June 29	835		11		20	15	45	2,303		
June 29	836		11		20	15	45	2,336		

No. 1, at Watervliet Arsenal, Sandy Hook, N. J., June 28 and 29, 1892.

charges and different method of putting up charges.]

Mean range.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Yards.		
3,446	.....	Gun mounted on experimental steel carriage. Cannon friction primers, model 1887; Frankford Arsenal, January 1891. Fired from board walk near field-gun platform. French quadrant used to give elevation. Charge of 11 ounces put up in one bag. Recoil restrained by 2½-inch rope, doubled.
3,293	.....	Charge of 11 ounces made up of one charge of 5 ounces and two charges of 3 ounces. Three bags tied together with twine to enable loading to be easily done. June 28, barometer, 29.85; thermometer, 70; humidity, 95.
2,338	.....	June 29, barometer, 29.92; thermometer, 75; humidity, 62. Fall of shot observed by Corporal Schrenz, Ordnance Detachment, on June 28. Fall of shot observed by Corporal Burt, Ordnance Detachment, on June 29. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
2,315	.....	

SUMMARY.

	Yards.
Mean range, maximum charge, I. K. H., viz, 16 ounces	3,446
Mean range, maximum charge, sphero-hexagonal, viz, 15 ounces	3,293
Mean range, with 11 ounces sphero-hexagonal in one bag	2,338
Mean range, with 11 ounces sphero-hexagonal in three bags	2,315

EXTRACTS FROM REPORTS OF CAPT. FRANK HEATH, COMMANDING THE SANDY HOOK PROVING GROUND.

JUNE 1, 1892.

* * * Drawings of the cartridge bags for this mortar filled with 3, 5, and 11 ounces of powder, respectively, are furnished herewith. These bags are made of the serge ordinarily used for field cartridges. To fabricate the 11-ounce bag a cylinder of proper height, as shown in the drawing, is made; to this cylinder the circular-shaped top and bottom pieces are sewed by machine; the seam in the cylinder is left open, and through it the charge is passed, after which the seam is sewed by hand. By these means the choke, as formed in the ordinary cartridge bag, and which occupies a considerable portion of the chamber space, is avoided. The 3 and 5 ounce bags are made by sewing together two circular disks of serge. * * *

(582A–'92.)

JULY 1, 1892.

* * * The maximum charges of sphero-hexagonal and I. K. H. powder that can readily be inserted in one cartridge bag are 15 and 16 ounces, respectively. With the first the mean range is 3,293 yards, with the second 3,446 yards—a difference in favor of the 16-ounce charge of 153 yards.

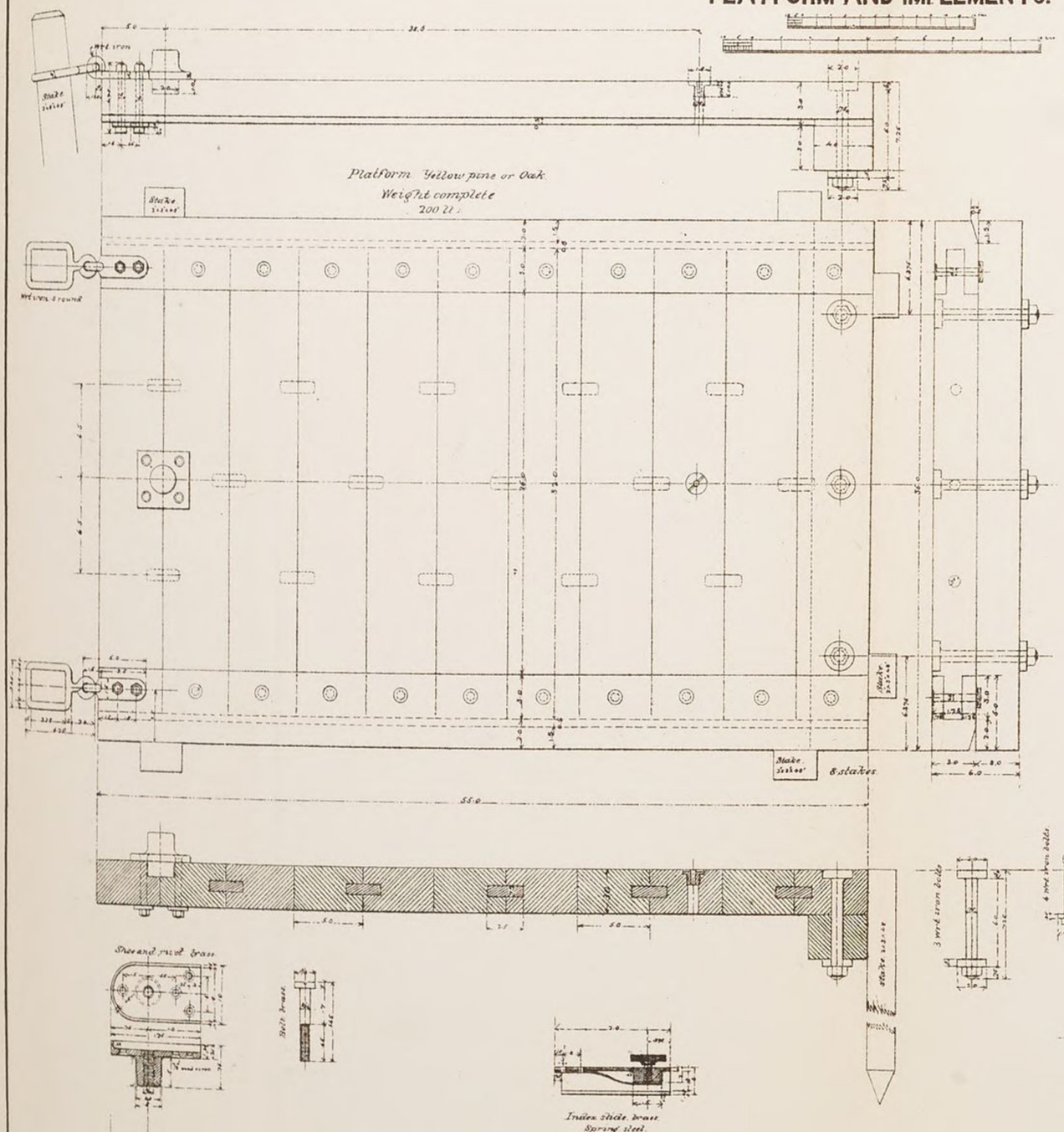
An 11-ounce charge made up of two 3 and one 5 ounce bags is practicable and convenient, and there is practically no difference in the range when put up in this way or in a single bag. It might be well in practice to put up the 11-ounce charge by binding together with a stout cord the three bags, so as to make one package ready for use. Such a package could be inserted more conveniently than by inserting them separately. The same remark applies to the 8-ounce charge. * * *

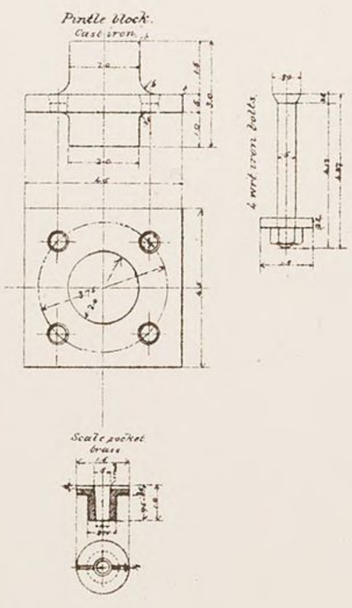
(582B–'92.)

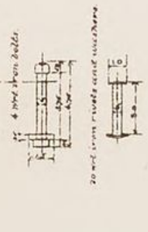
Ordnance Dept. U.S.A. July 10 1891

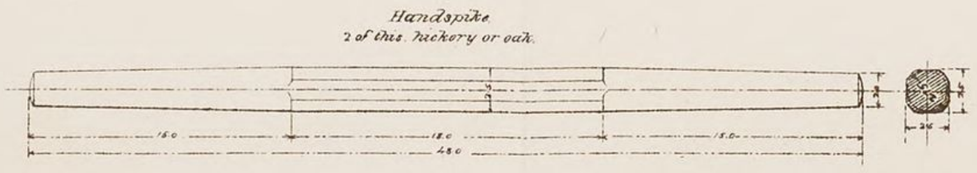
Revised July 22, 1892.

3.6 INCH B.L. FIELD MORTAR-CARRIAGE
PLATFORM AND IMPLEMENTS.









Approved.

D.W. Flagler
Brigadier General,
Chief of Ordnance.

R. Birnie
Captain Ordnance Dept.

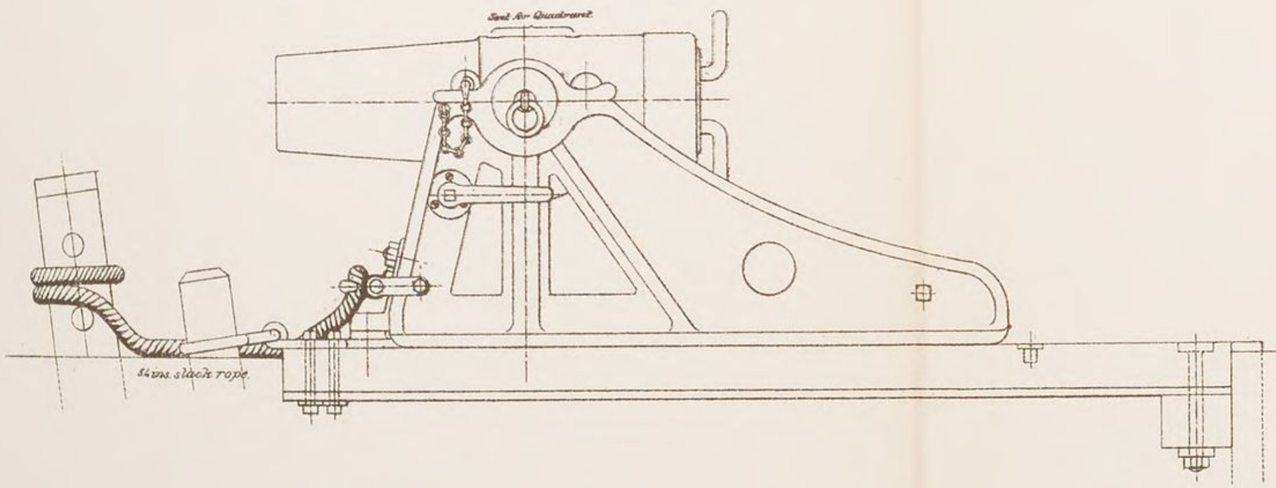
Appendix 32, 1892.

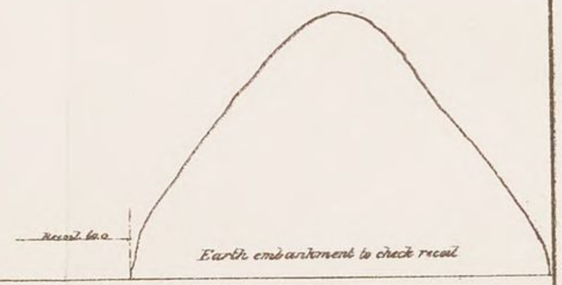
Ord 52 2

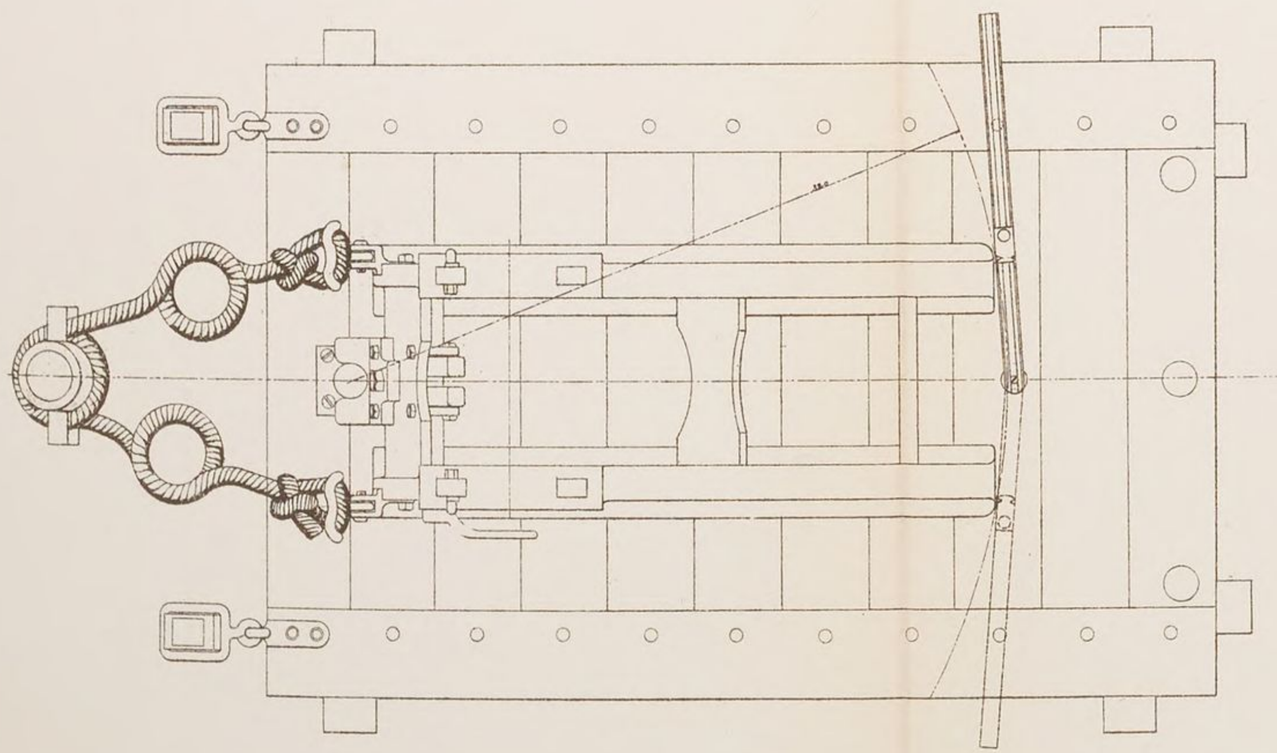
Ordnance Dept U.S.A. July 19. 1892.

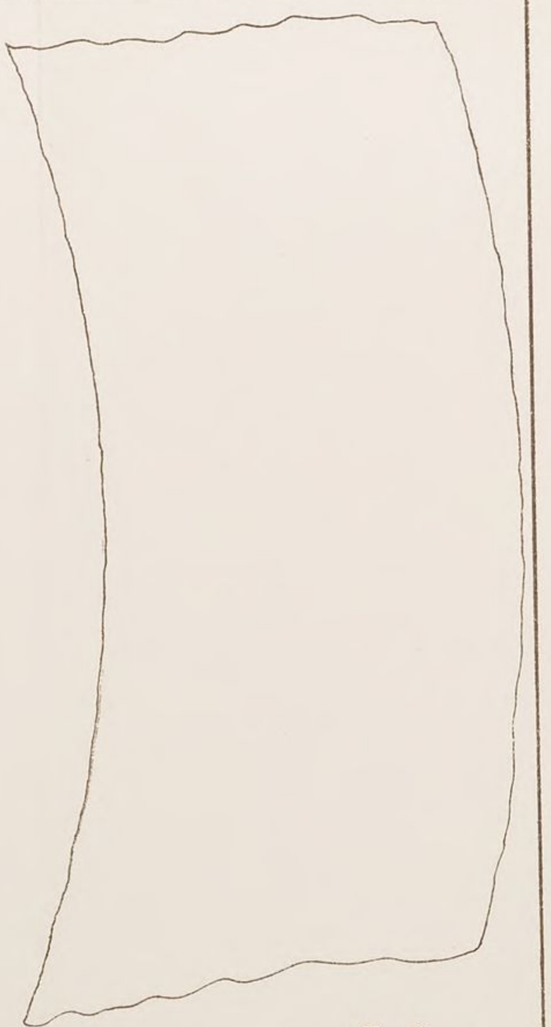
Revised July 22. 1892.

3.6 INCH B.L. FIELD MORTAR-CARRIAGE
AND
PLATFORM IN POSITION.









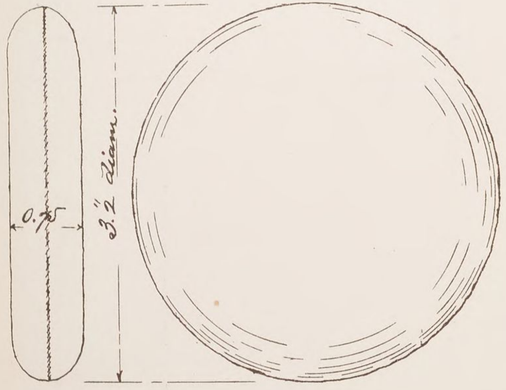
Approved.

D W Flagler
Brigadier General
Chief of Ordnance.

R. Birnie
Captain Ordnance Dept

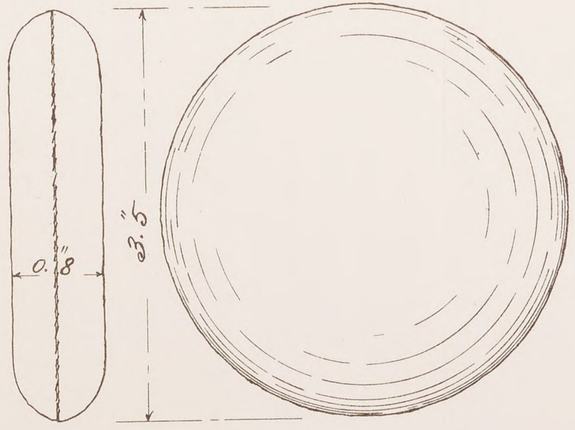
Appendix 32, 1892.

About an inch of seam left unsewed for filling and sewed up by hand.



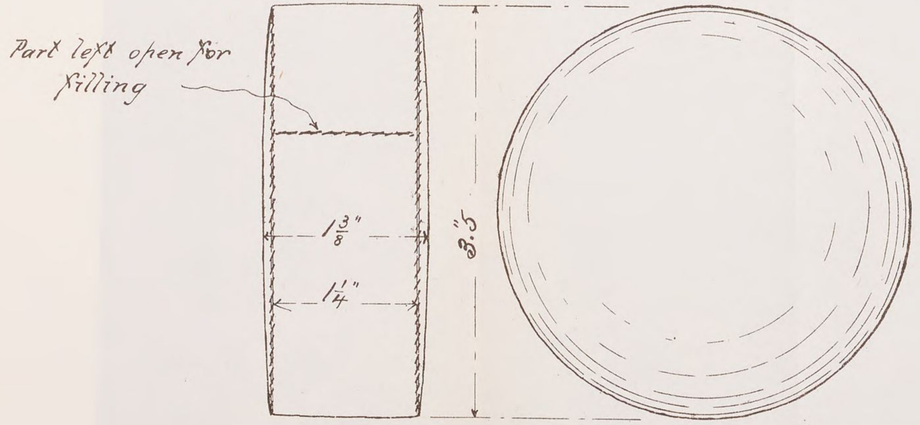
3 oz. Cartridge

Two circular pieces of cloth 4 inches diameter sewed together ¼ inch from edge, Seam turned inside. When filled with I.K.H. powder is about as above.



5 oz. Cartridge

Two circular pieces of cloth 4¼ inches diameter sewed together ¼ inch from edge, Seam turned inside. When filled with I.K.H. powder is about as above.



11 oz. Cartridge

Two circular pieces 4 inches diameter connected by body piece 1¼" wide, seam ¼ inch from edges. When filled with I.K.H. powder is about as above.

Appendix 32, 1892.

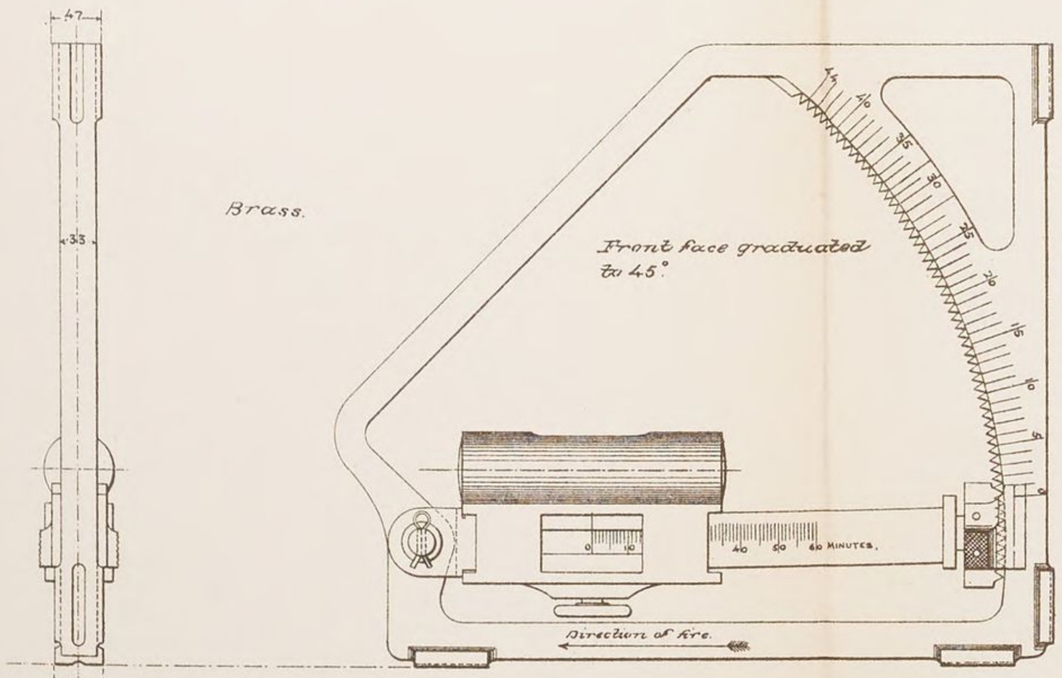
Cartridge Bags for 3."6 Mortar.

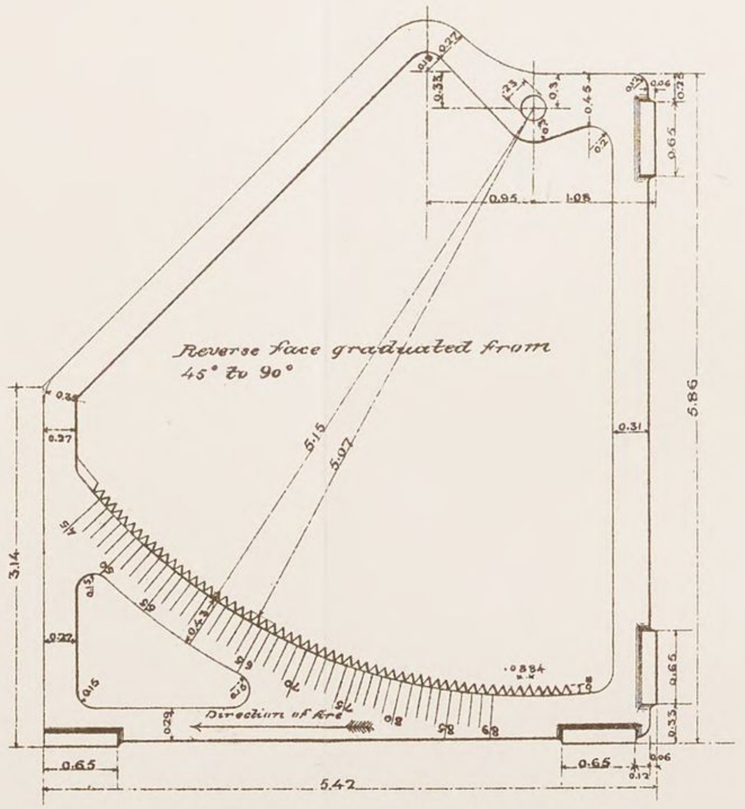
Frank Heath

CAPTAIN ORDNANCE DEPT. U.S.A. COMMANDING
SANDY HOOK PROVING GROUND, JUNE 1ST 1892.

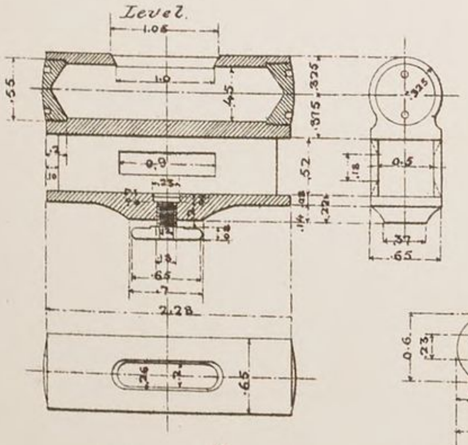
GUNNER'S QUADRANT.

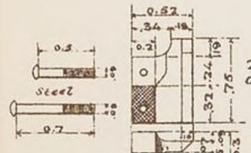
Brass.

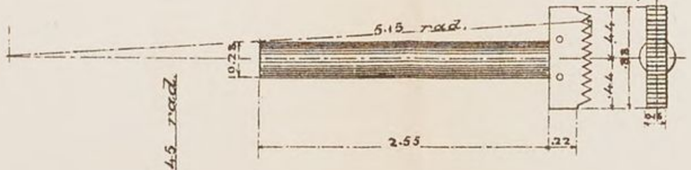


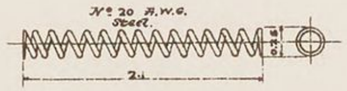


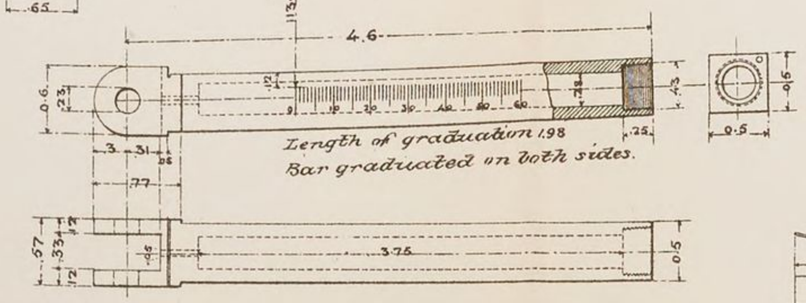
Dimensions taken from sample.

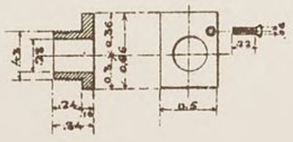


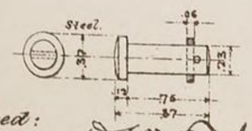


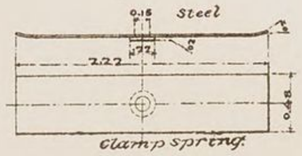












Approved:

D. W. Flagler
Brigadier General,
Chief of Ordnance.

Appendix 32, 1892.

R. Birnie
Captain Ordnance Dep't.

TARGET RECORD OF 3"6 B.L. Field Mortar Steel No 1
Watervliet Arsenal.

AT SANDY HOOK, N. J.

January 5th 1892

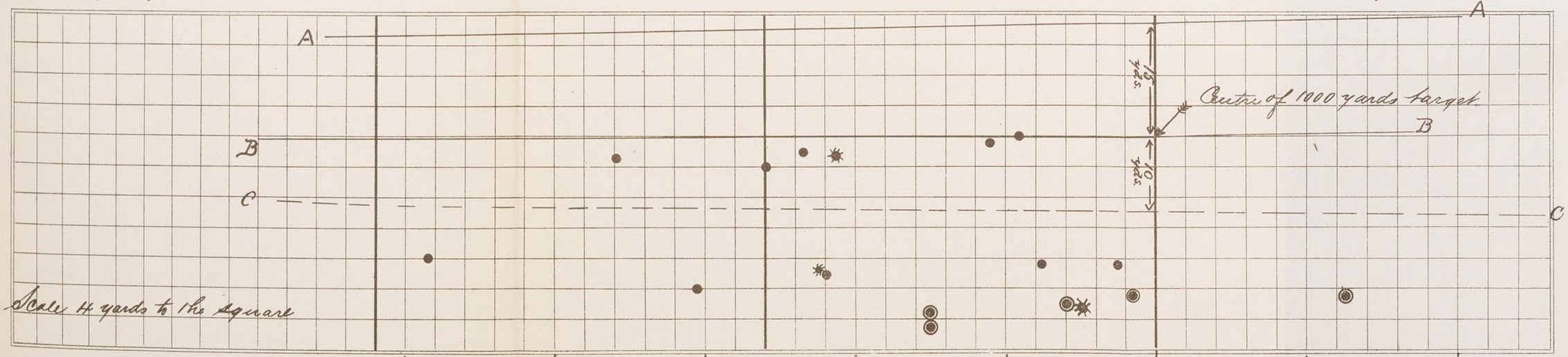
Target ..... from Gun.

Charge 5 oz

Elevation 45°

Number of shots fired: 15

Number of hits: 15



Lines of Fire
- A.A. red dots. Rounds 781 to 785 inc.
- B.B. black dots. Rounds 776 to 780 inc.
- C.C. black ring and red dots. Rounds 786 to 790 inc.

Wind 9 miles per hour.

Appendix 32, 1892.

Lieut. Ord. Dept. U.S.A.

Ord 52 2

A
B
C

TARGET RECORD OF 3.6 B.L. Field Mortar Steel No 1
Watervliet Arsenal

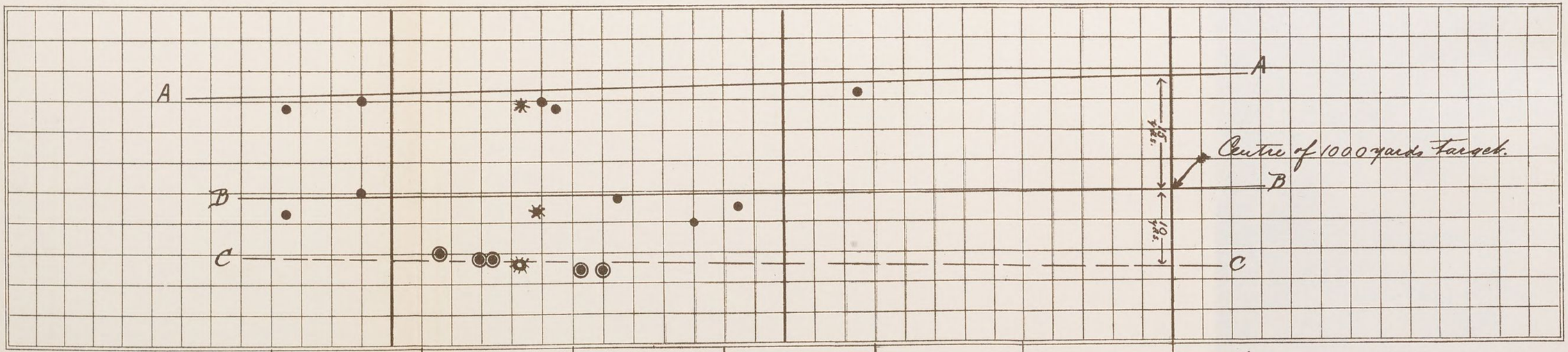
AT SANDY HOOK, N. J.
January 5th 1892

Target ..... from Gun.

Charge 8 ozs
Elevation 15°

Number of shots fired: 15

Number of hits: 15



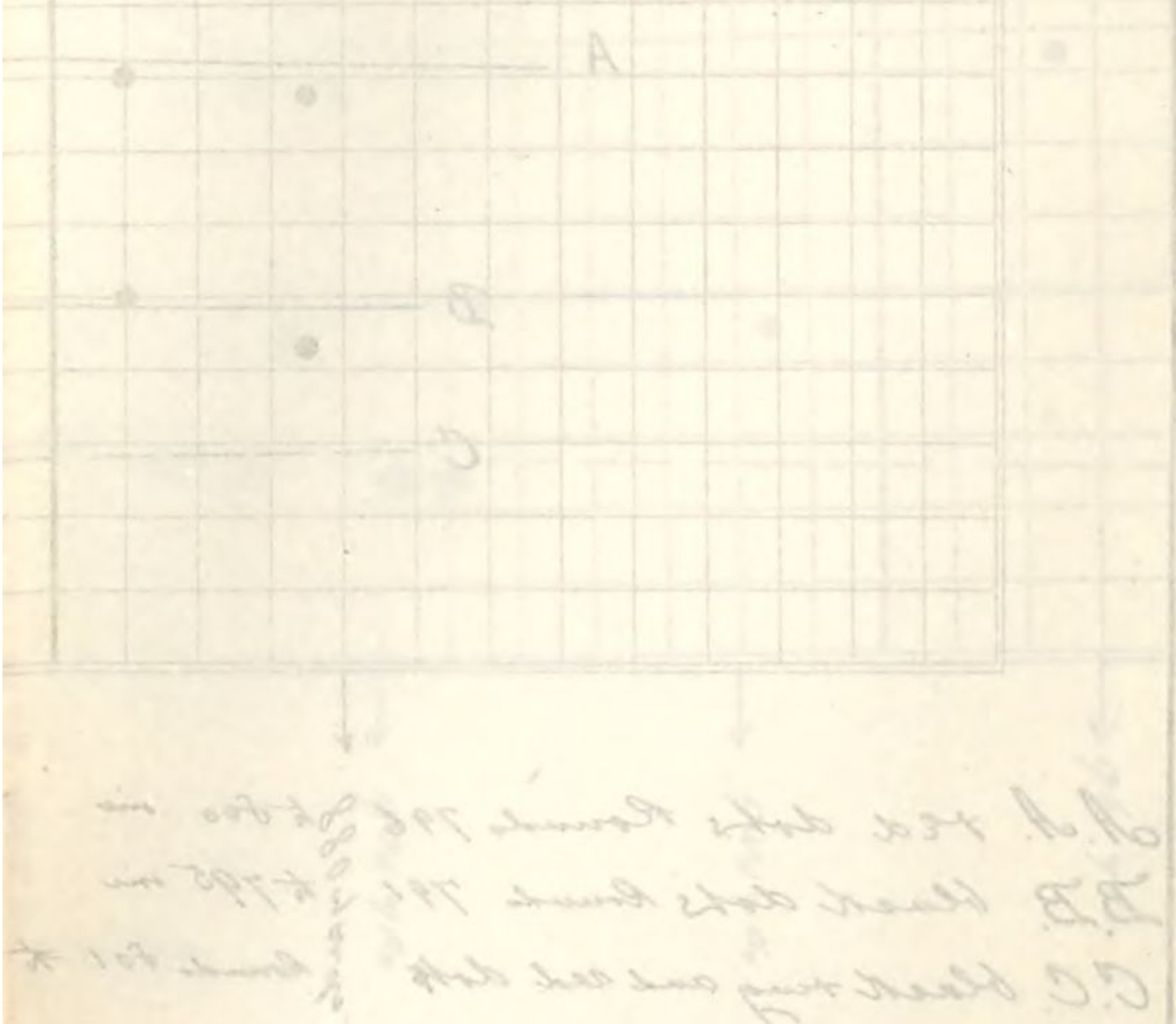
Lines of Fire
A.A. red dots Rounds 796 to 800 inc
B.B. black dots Rounds 791 to 795 inc
C.C. black ring and red dots Rounds 801. to 805 inc.

Wind 7 miles per hour.

Appendix 32, 1892.

Almond H. Fisher
Lieut. Ord Dept. U.S.A.

Ord 52 2


A
B
C

APPENDIX 33.

TEST OF MERRIAM'S BASE PERCUSSION FUSE.

(1 plate.)

SANDY HOOK PROVING GROUND,
New York, N. Y., February 1, 1892.

SIR: I have the honor to report that since the date (March 17, 1891) of the report of Capt. Shaler on the Merriam base percussion fuse further tests of the fuse have been made, from time to time, sufficient, it is believed, to determine its qualities and its fitness for introduction, at least for trial, into the service. As stated by Capt. Shaler, the fuse as originally presented was defective in that when sufficiently sensitive to insure explosion under the low velocities used in mortar-firing if the body with its contents were dropped through as small a height as 4½ feet, and should strike fair on the base the sleeve would slip over the spindle and leave the large ball free to move; and if in this condition it were to drop a second time accidental explosion would be very liable to occur.

Mr. Merriam's first idea was to insert a safety screw pin, which would prevent the slipping of the sleeve over the spindle, and on the 13th of April three fuses with this improvement were fired with good results. This method of insuring safety was, however, open to the objection that the screw pin must be taken out just before firing—an operation which, in the excitement of action, might easily be forgotten. It was, therefore, abandoned, and the fuse which is the subject of this report was presented for test.

This fuse, which is fully illustrated in the accompanying drawing, retains the original features of body or housing—one large and three small steel balls, but material modifications have been made in the minor details, by which the fuse is made to perform its functions with certainty, and absolute safety in transportation and handling is secured.

Referring to Fig. 4, which is a longitudinal section with the parts arranged as they exist previous to the firing of the shell, C represents the large ball or hammer, which is placed in the recess of the fuse body and held firmly in place to the rear by two retainers D, Fig. 10, on opposite sides of the ball. The rear ends of these retainers rest in a groove E, in the ball; the forward ends abut against a shoulder formed by the ring F. In recess G, with rear ends enlarged, are placed trips H, Fig. 11; by means of gas checks K, the heads of the trips are protected from the gas produced by the explosion of the propelling charge. In the front plug B are provided seats for the three percussion caps L, over each of which is placed the steel ball which enters its recess slightly more than a half diameter. Channels N intersect the cap seats and extend to the central chamber O. In this chamber is the delay valve Y, Fig. 6. The face of this valve is slightly recessed, and into this recess

is pressed mealed powder S. The mealed powder is held in place by the rim of metal at the edge and the center C, which are slightly undercut. Windows *b* expose the pressed powder to the igniting flame. The valve is free to move a slight amount longitudinally, but is guided laterally by wings *a a*, a^1 a^1, a^2 a^2, Fig. 5. The space between the wings provides a passage for flame and gases. Into the plug B is screwed the end piece R, Fig. 7; this piece has a chamber T at its center and a circumferential groove U, both containing the flashing charge, which may be either powder or gun-cotton. The sleeve W holds the contents of U in place.

The screw Z limits the longitudinal motion of the valve Y. When screwed well down the valve is held in its rearward position, the delay element is thrown out of action, the flame from the cap communicating directly with the flashing charge.

The spring Q holds the ball in its seat while the shell is moving in the air, the rim being held between the plug B and the ring F.

Before discharge of the gun the ball hammer C is securely held from moving forward against the caps by the retainers D. At the instant of firing the two trips H, being forced forward by the gas pressure at I, release the ends of the retainers, which are then entirely freed. These retainers, under the action of the setback and rotation of shell, arrange themselves along the outer wall of the cavity. The ball hammer is now free from any positive resistance, the spring Q holding the ball simply against accidental dislodgment.

The shell being suddenly retarded by striking the target the ball hammer continues its motion and strikes one or more of the small steel balls placed over the caps. The cap or caps are exploded, the flame being conducted through the channel N to chamber O. On account of the peculiar formation of its seat the hammer will explode one or more caps, even when the shell strikes squarely on its side, a feature which under certain circumstances of firing might be of great value.

By the retardation of the shell, all the parts of the fuse, except the ball hammer C and valve Y, have their velocity checked with the shell; the velocity of the valve Y, however, is not checked until it has moved a limited distance (about $\frac{1}{32}$ of an inch) and abuts against the rear face of R, presses against R with a force proportional to the rate of charge of velocity of shell, the pressure continuing as long as the shell is being violently retarded. While the valve Y is moving towards the face R the ball hammer is moving toward the firing balls M; but by reason of the greater travel of the ball and the opposing force of the spring Q the valve Y gets to its forward position before the explosion of the caps. The valve being tightly pressed against the face R, the flame from the caps can not reach the flashing charge directly but ignites through the windows *b b b* the pressed powder in the valve; the resulting gases escape by the channels *d d d*, Fig. 5, into the chamber surrounding the ball. As long as the valve is pressed against the face R, *i. e.*, as long as the shell is undergoing violent retardation, the powder in the valve burns slowly from the outer edge towards the center. The time required from the complete burning should exceed the time required to overcome the velocity of the shell while penetrating to the point at which the shell is desired to be burst. When the shell leaves the target or has reached the desired penetration, the force holding the valve against R is greatly diminished, and the gases from the burning powder force back the valve, pass over the unconsumed powder in the valve, and communicate with the flashing charge in T and U, which in turn ignites the bursting charge in the shell. By means of the screw

Z the forward movement of the valve may be prevented, and the flame from the caps reaches without delay the flashing charge in the central cavity.

Figs. 8 and 9 show how this delay principle may be applied to a fuse of ordinary construction.

Experiments were begun with this form of fuse on April 13 and were continued from time to time as opportunity permitted up to date. The objects of the firings were, first, to test the certainty of action; second, the strength of the housing to resist the powder pressure without deformation or leakage of gas; third, the extent and reliability of the delay action.

For the first test firings were made from the 3.6-inch B. L. rifle, 3.6-inch B. L. field mortar, and 12-inch B. L. mortar, as follows:

Certainty of action.

Rounds fired.	Weight of charge powder.	Weight of projectile.	Pressure per square inch of bore.	Fuse burst shell.	Fuse did not burst shell.	Burst in gun.
3.6-inch B. L. field mortar:	*Lbs. Oz.*	*Lbs. Oz.*	*Pounds.*			
4	0 4	19 6	3,610	4	.....	.....
4	1 0	20 0	21,487	4	.....	.....
3.6-inch B. L. rifle No. 1:						
2	1 8	19 9½	6,800	2	.....	.....
1	2 6	19 5	12,525	1	.....	.....
4	4 6	19 15	.....	4	.....	.....
29	4 12	19 15	38,687	25	1	3
7	5 0	20 0	.....	6	.....	1
12-inch B. L. mortar:						
2	22 0	638 12	8,557	2	.....	.....
2	25 0	614 8	4,975	2	.....	.....
1	40 0	617 0	9,104	1	.....	.....
1	50 0	629 8	13,283	.....	.....	1
57	.....	.....	.....	51	1	5

As but one failure to burst was recorded, and that when firing over water, these results indicate that absolute certainty of action may be expected of these fuses under all conditions of pressures likely to be required in service either with guns or mortars. As the lot of shells used were found in subsequent trials to be very defective, it is probable that the bursts in gun recorded were due to the shell rather than the fuses.

To test the strength of the housing, the latter was screwed into a steel plug prepared for the purpose. It was then placed in the bottom of the cartridge in the same manner as ordinary pressure plug. The depression of the face of the housing due to the powder pressure was noted and also any signs of leakage of gas through its pores. As a result of these trials, it was found that "console metal" 55 per cent copper, 44½ per cent zinc, and ½ per cent tin was well adapted for the purpose.

During the tests the delay action was subjected to slight modifications with a view of shortening the delay by allowing freer access to the flashing charge and simplifying the parts, the result being the delay as above described.

Firings were made through butts of sand 3 inches or 4 inches thick, wooden screens of various thicknesses, or other screens being placed beyond the first to catch the fragments. In all cases a distinct difference could be noted in the time of bursts with and without the delay. In the final trial with 3.6-inch gun, beginning with round 1,973 to 1,992,

the board target was gradually increased in thickness from 16 to 51 inches. The time of burst after the shell had left the target was in all instances approximately the same, the diminishing distances of the points of burst being caused by the changes in velocity due to the constantly increasing thickness of the target. It may be inferred therefore that, within limits, the automatic character of the delay is established with the delay cut out, the target being 51 inches thick, explosion took place immediately at rear of target, proving that even without the delay a sensible time is required to produce the explosion of the shell.

In the final test two shells, one with and one without the delay, were also fired from the 12-inch B. L. mortar. It was thought that possibly the crater made by shell having the delay would be greater than the other; the reverse, however, was found to be the case, the crater made by the latter being slightly the greater. It is difficult to account for this, except on the assumption that a deeper and steeper hole having been made with the delay the sand fell back more easily to partially refill the crater.

The results of these tests indicate that further trials are necessary in order to demonstrate that the delay action will or will not do that which the inventor claims for it. It is believed, however, that the fuse as a whole is an admirable invention, and well adapted for use in the service, especially with guns or mortars of large caliber.

Very respectfully, your obedient servant,

FRANK HEATH,
Captain, Ord. Dept., U. S. Army, Commanding.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

(640–'92)

Record of firing with 3.6-inch B. L. field mortar (steel), No. 1,

[Object of firing, to test Merriam

No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Fuse No.	Pressure per square inch of bore.	Recoil.
		Oz.		*Lbs. Oz.*	°		*Lbs.*	*Ft. In.*
715	Du Pont's I. K. H.; lot 27; granulation, 2,605; density, 1.725; gravimetric, 2,605.	4	Shell (banded), experimental lot 249.	18 4 1 2 fuse. 19 6	15	56	No. 4, 3,665	5 2
716		4		18 8 1 2 fuse. 19 10	15	54	No. 5, 3,555	5 2
717		4		18 4 1 2 fuse. 19 6	15	57	.....	5 0

[Object of firing, to test Merriam

718	Du Pont's I. K. H.; lot 27; density, 2,605.	4	Shell (banded), experimental lot 249.	18 7 15 fuse. 19 6	15	2	.....	5 1
719		4		18 6 14 fuse. 19 4	15	1	.....	5 0
720	Du Pont's I. K. H.; lot 27; density, 1.725; granulation, 2,605.	3	Shell (banded), experimental lot 249.	18 4 15 fuse. 12 rifle powder, bursting charge. 19 15	15	10	.....	3 6

Watervliet Arsenal, at Sandy Hook, N. J., April 13, 1891.

base percussion fuse (automatic).]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Struck ground at about 500 yards; shell recovered; fuse was found to have ignited.	Mortar mounted on experimental steel carriage, made at Watervleit Arsenal. Cannon friction primers, model 1887. Fired down the beach. Uncompressed copper cylinders and tables of 1890.
Struck ground at about 500 yards; shell recovered; fuse was found to have ignited.	
Struck ground at about 500 yards; shell recovered; fuse was found to have ignited.	

base percussion fuse, with safety screw pin.]

Shell lost.	Fired down the beach. Firing conducted by the proof officer.
Struck ground at about 500 yards; shell recovered; fuse was found to have ignited.	
Shell broke in two pieces during flight; base recovered; fuse was found to have ignited.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test Merriam

Date.	No. of fire.	Powder.		Projectile.		Fuse marked.	Elevation.
		Kind.	Weight.	Kind.	Weight.		
			Lbs. Oz.		*Lbs. Oz.*		° ′
P. M. Apr. 13	365	Laflin & Rand's I. K., lot 4; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental lot 249, altered to receive fuse.	18 1 1 1 fuse. 12 rifle powder. 19 14	.....	2 20

[Object of firing, to test Merriam

P. M. June 2	997	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell, lot 249, altered to receive Merriam base percussion fuse.	19 4 shell and fuse. 3 rifle powder, bursting charge. 19 7	No. 58	05
June 2	998		4 12		19 7 fuse and shell. 3 rifle powder, bursting charge. 19 10	No. 60	2 00
June 2	999		4 12		19 8 shell and fuse.	No. 59	05

Arsenal, at Sandy Hook, N. J., April 13 and June 2, 1891.

base percussion fuse (automatic).]

Pressure per square inch of bore.	Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*		
No. 3, 34,400	16	Fuse stamped No. 55 on base; shell broke up in gun; fuse was not recovered.	Gun mounted on Buffington steel field carriage No. 4, with old spiral-spring brakes. Fired at 1-mile target. Cannon friction primers, model 1887. Uncompressed copper cylinders and tables of 1890. Firing conducted by the proof officer.

base percussion fuse (automatic).]

No. 3, 37,360	16	Fuse had an extra heavy head; shell burst on striking butt.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; spiral-spring brake on left wheel; clevis attachment. Cannon friction primers, model 1887. Rounds 997 and 999 fired into field butt, section 2. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
No. 3, 39,995	16	Fuse had a medium weight head; fired to sea, ricocheted once, did not burst.	
No. 3, 36,970	17	Fuse had a light weight head; shell not recovered.	

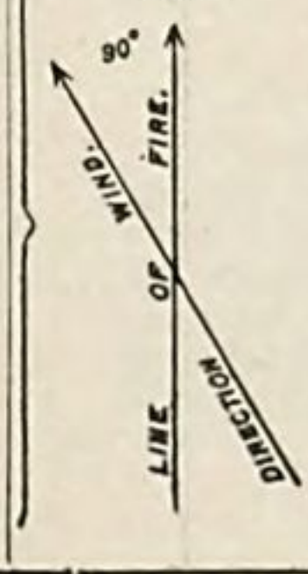
Record of firing with 3.6-inch B. L. field mortar (steel), No. 1,

[Object of firing, to test Merriam

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Fuse No.
		Kind.	Weight.	Kind.	Weight.		
			Lb. Oz.		*Lb. Oz.*	° ′	
June 2	721	Du Pont's L. K. H., lot 27; density, 1.725; granulation, 2,605.	1 0	Rebanded shell, altered to receive Merriam fuse.	19 3 shell and fuse. 13 rifle powder, bursting charge. 20 0	2 00	61
June 2	722	Du Pont's L. K. H., lot 27; density, 1.725; granulation, 2,605.	1 0	Shell, lot 249, altered to receive Merriam fuse.	19 8 shell and fuse. 13 rifle powder, bursting charge. 20 5	30	62
June 2	723	Du Pont's L. K. H., lot 27; density, 1.725; granulation, 2,605.	1 0	Shell, lot 249, altered to receive Merriam fuse.	19 7½ shell and fuse. 13 rifle powder, bursting charge. 20 4½	30	63
Aug. 25	724	Du Pont's L. K. H., lot 27; density, 1.725; granulation 2,605.	0 4	Shell altered to receive fuse, lot 249.	18 1 1 1 fuse. 19 2	15 00	16
Aug. 25	725	Du Pont's L. K. H., lot 27; density, 1.725; granulation 2,605.	1 0	Shell altered to receive fuse, lot 249.	17 13 1 1 fuse. 12 powder, bursting charge. 19 10	1 00	74

Watervliet Arsenal, Sandy Hook, N. J., June 2 and August 25, 1891.

base percussion fuse (automatic).]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*			
No. 4, 21, 460	.....	.....	Shell burst over butt. Copper cylinder of 9,000 pounds initial compression and tables of 1887.	Mortar mounted on new experimental steel carriage made at Watervliet Arsenal. Recoil restrained by 2½ inch rope fastened to post in front of carriage and to iron bar passed through loops of carriage. Fired at sand butt. Cannon friction primers, model 1887. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
No. 5, 21, 280	.....	.....	Shell burst on striking butt. Several grains of unburned powder found in chamber. Rope restraining recoil broke. Mortar turned over. Copper cylinder of 9,000 pounds initial compression and tables of 1887.	
No. 4, 21, 720	.....	.....	First primer failed to ignite cartridge; shell burst on striking butt. Copper cylinder of 18,000 pounds initial compression and tables of 1890.	
No. 1, 3, 610	3	Ten miles an hour. 	Shell struck the ground about 500 yards from gun; shell recovered; fuse was found to have ignited. Uncompressed copper cylinder and tables of 1890.	Mortar mounted on new steel experimental carriage made at Watervliet Arsenal. Cannon friction primers, model 1887. Fired down the beach. Fuses with medium weight head. Firing conducted by Lieut. W. W. Gibson, Ordnance Department assistant proof officer.
.....	6		Shell struck the ground about 300 yards from gun, and burst; fuse recovered.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test Merriam

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Fuse No.	Pressure per square inch of bore.
		Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	*Lbs. Oz.*	Shell altered to receive fuse; lot 249.	*Lbs. Oz.*	° ′		*Pounds.*
P. M. Aug. 25	1391		2 6		17 14 1 1 fuse. 6 powder, bursting charge. 19 5	30	66	No. 3, 12, 525
Aug. 25	1392		4 12		17 15 1 1 fuse. 7½ powder, bursting charge. 19 7½	15	69	No. 3, 34, 460

[Object of firing, experiments with Merriam fuses to

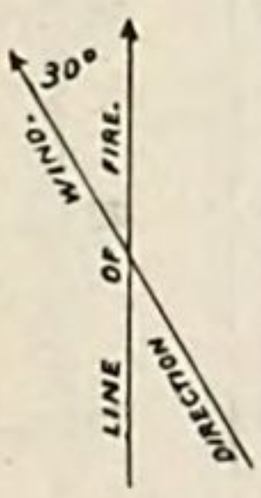
P. M. Sept. 11	1546	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	3 8	Shell, lot 326.	18 13 1 3 sand. 20 0	.....	67	No. 3, 21, 635

[Object of firing, experiments with Merriam fuses,

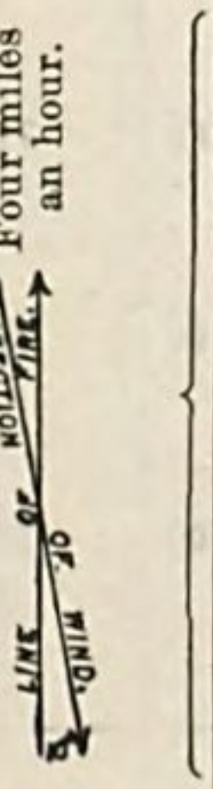
P. M. Sept. 11	1547	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 12	Shell, lot 326.	18 14 1 2 sand. 20 0	.....	67	No. 3, 36, 660
Sept. 11	1548		4 12		18 15 1 1 sand. 20 0	.....	67	No. 3, 35, 600
Sept. 11	1549		4 12		18 14 1 2 sand. 20 0	.....	67	No. 3, 36, 510
Sept. 11	1550		4 12		18 14 1 2 sand. 20 0	.....	67	No. 3, 36, 120

Arsenal, Sandy Hook, N. J., August 25 and September 11, 1891.

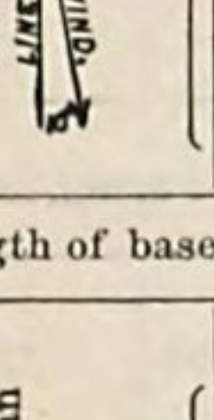
base percussion fuse (automatic).]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
.....	Ten miles an hour. 	Shell struck the ground about 500 yards from gun and burst. Copper cylinders of 9,000 pounds initial compression and tables of 1890.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; bow-spring brake on left wheel. Cannon friction primers, model 1887.
.....		Shell burst in gun; large fragments struck the ground about 500 yards from gun. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	Fired down the beach. Fuses had medium weight head. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.

test strength of base-tightening of pistons and threads.]

12	Four miles an hour. 	Fuse housing with front end closed, with plug containing wax to receive force of retainers at instant of release; ball released; retainers showed slight indentation in wax. No leakage in pistons or threads.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on right wheel; old spiral-spring brake on left wheel. Friction primers long. Copper cylinders of 9,000 pounds initial compression and tables of 1887. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.

to test for strength of base under full charge.]

12	Four miles an hour. 	Ball retainers and closing plug removed; base slightly depressed. Housing upset; no leakage shown.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on right wheel; old spiral-spring brake on left wheel. Fuse in housing placed in base of cartridge bag. Friction primers long. Fired to sea. Copper cylinders of 28,000 pounds initial compression and tables of 1890 used in round 1,547. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 1,548 to 1,550, inclusive. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
12		Ball retainers and closing plug removed; base reduced by $\frac{1}{16}$ inch; slight depression.	
12		Ball retainers and closing plug removed; base reduced by $\frac{5}{32}$ inch; base depressed about $\frac{1}{100}$ inch at center.	
12		Ball retainers and closing plug removed; base reduced by $\frac{1}{64}$ inch; base depressed $\frac{7}{32}$ inch.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, experiments with Merriam fuses, to test

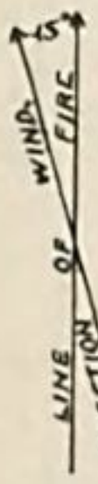
Date.	No. of fire.	Powder.		Projectile.		Elevation.	Fuse No.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′		*Pounds.*
Sept. 16	1584	Laflin & Rand's L. K., lot 7; density, 1.710; granulation, 2,360.	4 10	Shell, lot 326.	18 15 1 1 sand. 20 0	5 00	68	No. 3, 37,400
Sept. 16	1585		4 10		18 14 1 2 sand. 20 0	5 00	65	.....
Sept. 16	1586		4 10		18 13 1 3 sand. 20 0	5 00	73	.....
Sept. 16	1587		4 10		18 15 1 1 sand. 20 0	5 00	72	.....
Sept. 16	1588		4 10		18 14 1 2 sand. 20 0	5 00	70	.....
Sept. 16	1589		4 10		18 13 1 3 sand. 20 0	5 00	75	.....
Sept. 16	1590		4 10		18 14 1 2 sand. 20 0	5 00	71	.....
Sept. 16	1591		4 10		18 15 1 1 sand. 20 0	5 00	74	.....
Sept. 16	1592		4 10		18 15 1 1 sand. 20 0	5 00	76	.....

[Object of firing, experiments with

P. M.								
Sept. 29	1731	Laflin & Rand's L. K., lot 7; density, 1.710; granulation, 2,360.	1 8	Shell, lot 326, altered to receive fuse.	19 5 shell and fuse. 6 rifle powder, bursting charge. 19 11	30	73	No. 3, less than 9,000.
Sept. 29	1732		1 8		19 2 shell and fuse. 6 rifle powder, bursting charge. 19 8	3 30	70	No. 3, 6,800
Sept. 29	1733		4 12		19 0 shell and fuse. 6 rifle powder, bursting charge. 19 6	3 30	65	No. 3, 33,120

Arsenal, at Sandy Hook, N. J., September 16 and 29, 1891.

fuse bases under pressure in excess of service pressure.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
9	Ten miles an hour.	Base depressed $\frac{1}{64}$ inch. Joint and pistons tight. Ball released.	
10		Blow holes in casting; gas penetrated into cavity, but small charge not ignited. Ball released.	
10		Depression scarcely perceptible. Ball released.	
10		Depression not perceptible. Housing beginning to show signs of upsetting. Ball released.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Cannon friction primers, model 1887. Bases of 10 per cent aluminium bronze.
10		Fuse struck rock in falling from gun. Ball released. No depression of base.	Fired from platform on fort wall to sea. Fuse in housing placed in base of cartridge bag.
10		Blow holes in casting, but gas did not penetrate. No depression of base.	Copper cylinder of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
10		Ball released. No depression.	
10		Fired with no ball. No depression.	
10		Blow holes in base, and gas penetrated. Fired with no ball.	

Merriam base percussion fuse.]

8	Twenty miles an hour.	Shell burst on striking ground 300 yards from gun. Copper cylinders of 9,000 pounds initial compression and tables of 1890.	
8		Shell burst on striking ground 400 yards from gun. Uncompressed copper cylinders and tables of 1890.	Gun mounted on Buffington steel field carriage (light) No. 17. Bow-spring brake on right wheel; old spiral-spring brake on left wheel. Cannon friction primers, model 1887. Fired down the beach. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
8		Fuse inserted in shell with difficulty. Shell burst on striking ground 1 mile from gun. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	

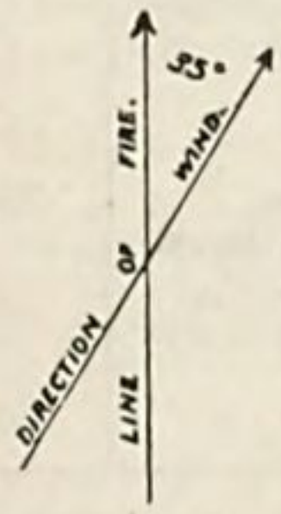
Record of firing with 12-inch B. L. rifled mortar (cast-iron), No. 2 (steel hooped,

[Objects of firing, experiments with

	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.
		Kind.	Weight.	Kind.	Weight.		
			Pounds.		*Lbs. Oz.*	*Inches.*	°
P. M..	22	Du Pont's brown prismatic R. H. B., lot 5; 61 prisms in cross-section; density, 1.830.	263 prisms, brown. 7 prisms, black.	25	Mortar shell, lot 287, with Merriam base percussion fuse.	596 0 rifle powder, bursting charge. 15 0 1 0 fuse. 612 0	91.75	60
	23		263 prisms, brown. 7 prisms, black.	25		601 0 rifle powder, bursting charge. 15 0 1 0 fuse. 617 0	91.75	60
	24		423 prisms, brown. 7 prisms, black.	40		601 0 rifle powder, bursting charge. 15 0 1 0 fuse. 617 0	91.75	30
	25		502 prisms, brown. 7 prisms, black.	50		602 0 rifle powder, bursting charge. 26 8 1 0 fuse. 629 8	91.75	30

14¼ tons), Builders' Iron Foundry, at Sandy Hook, N. J., September 29, 1891.

Merriam base percussion fuse.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*			
C less than 9,000 F 6,200	2	Twenty miles an hour.	Number on base of fuse 72. First primer failed to ignite charge. Shell burst on striking ground near 3,000-yards bomb proof. Copper cylinders of 9,000 pounds initial compression and tables of 1890, gauge C. Uncompressed cylinders and tables of 1890 used in gauge F.	Mortar mounted on modified Krupp mortar carriage.
C 3,500 F 4,000	2		Number on base of fuse 71. Shell burst on striking ground, about 3,000 yards from mortar. Uncompressed copper cylinders and tables of 1890.	Obturating electric primer. Before this firing obturating cups removed, and marks made by escaping gas smoothed off.
C 9,083 F 9,125	3		Number on base of fuse 74. Shell burst on striking ground, about 4,000 yards from mortar. Copper cylinders of 9,000 pounds initial compression and tables of 1890.	Fired down the beach. Translating roller removed before each round. Cartridge bag cut.
C 13,283 F less than 18,000	3		Number on base of fuse 68. Shell broke up in mortar. Copper cylinders of 9,000 pounds initial compression and tables of 1890 used in gauge C. Copper cylinders of 18,000 pounds initial compression and tables of 1890 used in gauge F.	Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to

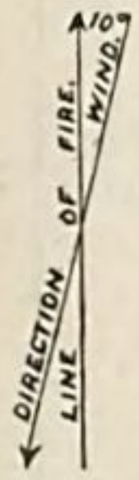
Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	No. of fuse.	Elevation.	Pressure per square inch of bore.
			Lbs.		*Lbs. Oz.*		° ′	*Pounds.*
P. M. Oct. 29	1753	Laflin & Rand's L. K., lot 7; density, 1.710; granulation 2,360.	5	Shell, lot 326, altered to receive Merriam fuse.	19 4 including fuse. 10 rifle powder, bursting charge. 19 14	77	.....	.....
Oct. 29	1754		5		19 2 including fuse. 10 rifle powder, bursting charge. 19 12	78	.....	.....
Oct. 29	1755		5		19 4 including fuse. 10 rifle powder, bursting charge. 19 14	74	.....	.....
Oct. 29	1756		5		19 3 including fuse. 10 rifle powder, bursting charge. 19 13	75	.....	.....
Oct. 29	1757		5		19 2 including fuse. 10 rifle powder, bursting charge. 19 12	79	.....	.....

[Object of firing, experiments

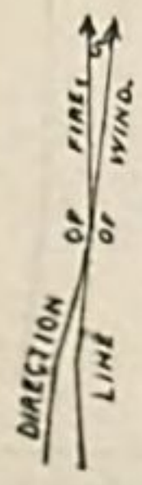
P. M. Nov. 11	1780	Laflin & Rand's L. K., lot 7; density, 1.710; granulation, 2,360.	5	Shell, lot 336, altered for fuse.	18 4 shell. 1 4 fuse. 10 powder, bursting charge. 20 2	80	.....	.....
Nov. 11	1781		5		18 4 shell. 1 3 fuse. 10 powder, bursting charge. 20 1	81	.....	.....

Arsenal, at Sandy Hook, N. J., October 29 and November 11, 1891.

test Merriam fuses.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
14	Sixteen miles an hour. 	Fuse with automatic delay. Distance of 1-inch screen from 2-inch screen 25 feet. Shell passed through both screens, making a clean hole, and burst after passing through second one. Gun hung fire.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887.
15		Fuse with automatic delay. Distance of 1-inch screen from 2-inch screen 75 feet. Shell burst in gun.	Base of shell turned down $\frac{1}{16}$ inch for a distance of $1\frac{3}{8}$ inches from base which included $\frac{1}{8}$ inch of the rotating band. Copper bonnet slightly lipped at edges, forced on rear end of projectile so that lips engaged on copper band.
15		Fuse without delay. Fired to burst at 2-inch screen. Burst at screen.	Fired at screen 2 inches thick, 6 feet high, and 4 feet wide, 150 feet from gun. Aimed at center.
14		Fuse without delay. Fired to burst at 2-inch screen. Burst at screen.	Two screens used. The first one to burst shell and the second to record place of bursting. Second screen 8 feet high, 6 feet wide, by 1 inch thick.
15		Fuse with automatic delay. Shell passed through 2-inch screen and burst at 1-inch screen 75 feet beyond.	Frankford Arsenal sight used. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.

with Merriman fuse.]

33	Six miles an hour. 	First screen 6 feet high, 4 feet wide, and 2 inches thick, 150 feet from gun. Second screen 8 feet high, 6 feet wide, and 1 inch thick, 75 feet from first screen. First primer failed. Shell struck in water about 500 yards beyond second screen and burst.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fuse with automatic delay. Fired at screens.
17		First screen 6 feet high, 4feet wide, and 3 inches thick, 150 feet from gun. Second screen 8 feet high, 6 feet wide, and 1 inch thick, 75 feet from first screen. Shell burst between first and second screens.	Impressions taken of the shot and powder chamber before this firing showed deep scorings at the beginning of the rifling and along the top of the powder chamber, foward of the vent. A series of marks beginning immediately at the vent where their depth is considerable, and extending forward to the end of the powder chamber, where the depth is less, bear much the appearance of a crack in the metal of the tube. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervlie

[Object of firing, test

Date.	No. of fire.	Powder.		Projectile.		No. of fuse.	Elevation.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
P. M. Nov. 24	1802	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	*Lbs. Oz.* 4 12	Shell, lot 336, altered for fuse.	*Lbs. Oz.* 18 5 shell. 10 rifle powder, bursting charge. 1 4 fuse. 20 3	82	° ′	*Pounds.* No. 8, 32,400
Nov. 24	1803		4 12		18 6 shell. 10 rifle powder, bursting charge. 1 4 fuse. 20 4	83	.....	No. 8, 33,836
Nov. 24	1804		4 12		18 4 shell. 10 rifle powder, bursting charge. 1 4 fuse. 20 2	84	.....	No. 8, 32,883
Nov. 24	1805		4 12		18 2 shell. 10 rifle powder, bursting charge. 1 4 fuse. 20 0	85	.....	No. 8, 32,800
Dec. 9	1921	Du Pont's grain V. V., lot 2; density, ; granulation, 2,585.	4 12	Shell, lot 336,	18 5 shell. 10 rifle powder, bursting charge. 1 2 fuse. 20 1	89	.....	.....
Dec. 9	1922		4 12		18 5 shell. 10 rifle powder, bursting charge. 1 2 fuse. 20 1	88	.....	.....
Dec. 9	1924		4 12		18 4 shell. 10 rifle powder, bursting charge. 1 2 fuse. 20 0	86	.....	.....
Dec. 9	1923		4 12		18 7 shell. 10 rifle powder, bursting charge. 1 2 fuse. 20 3	87	.....	.....

[Object of firing, to test strength

P. M. Dec. 9	1925	V. V., lot 2. V. V., lot 3.	3 0 1 8 4 8	Shell, lot 336.	18 13 1 3 sand. 20 0	5	.....	.....

Arsenal, at Sandy Hook, N. J., November 24 and December 9, 1891.

of Merriam fuses.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
12	From rear 35° right, 20 miles an hour.	To test automatic delay in thick target. Butt not boarded up behind, and sand at natural slope. Shell burst in box; smoke of burst seen behind box.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes.
13		To test automatic delay in thick target. Back of box boarded up and filled with sand. Shell burst in box. Explosion of shell knocked out, and broke all rear boards. Marks of explosion found on fragments of boards. Fragments of shell struck water about 100 yards beyond.	Fired into box filled with sand; size 4 by 4 feet and 4 feet high; about 65 feet from gun. Cannon friction primers, model 1887.
14		To test automatic delay in thin target. Screen 40 feet in front of gun and 25 feet from box. Shell passed through screen and burst after entering box. Powder marks of explosion seen on inside of front boards.	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
14		To determine quickest action possible. Automatic delay cut out. Screen 35 feet in front of gun and 30 feet from box. Shell passed through and burst at screen. Fragments struck box and also passed beyond into water.	Fired at screen 6 feet high, 4 feet wide, and 3 inches thick, placed in front of box. Cannon friction primers, model 1887. Pressures taken by Lieut. C. B. Wheeler, Ordnance Department.
20	From rear .05°, 19 miles an hour.	Fuse with automatic delay. Arranged to explode after passing through earth in box. Shell burst in box.	Gun mounted on Buffington steel field carriage No. 4, with bow-spring brakes.
17		Fuse without delay. Shell exploded just at penetration, and blackened inside of hole made by projectile.	Fired into box filled with sand; size 4 by 3 feet and 4 feet high, about 65 feet from gun. Cannon friction primers, model 1887.
16	From rear and right .05°, 19 miles an hour.	Fuse with automatic delay. Arranged to explode at screen after passing through. First marks of fragments in sand about 10 feet behind screen.	Fired at screen placed 30 feet in front of box and 35 feet from gun; size 4 by 6 feet by 3 inches.
17		Fuse with automatic delay. First marks of fragments in sand, about 16 feet behind screen.	Cannon friction primers, model 1887. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.

of base, Merriam fuse.]

16	From rear and right .05°, 19 miles an hour.	Fuse base in housing placed in bottom of cartridge bag. Projectile passed through box and recovered about 50 feet beyond. Base depressed $\frac{3}{64}$ of an inch.	Fired into box filled with sand, 4 by 4 feet and 4 feet high, 65 feet from gun. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to determine whether friction in passing through box filled with

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	No. of fuse.	Elevation.	Pressure per square inch of bore.
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Base.*	° ′	*Pounds.*
Dec. 15	1957	Du Pont's grain V. V., lot 3; density, 1.725; granulation, 2,720.	4 8	Shell, lot 326.	18 15 shell. 10 powder. 19 9	7	.....	.....
Dec. 15	1958	Du Pont's grain V. V., lot 3; density, 1.725; granulation, 2,720.	4 12	Shell, lot 326.	18 15 shell. 10 powder. 19 9	.....	.....	.....

[Object of firing, experiments

P. M.								
Dec. 15	1959	Du Pont's grain V. V., lot 3; density, 1,725; granulation, 2,720.	4 12	Shell, lot 326.	18 1 shell. 1 4 fuse. 10 powder. 19 15	90	.....	.....
Dec. 15	1960	Du Pont's grain V. V., lot 3; density, 1,725; granulation, 2,720.	4 12	Shell, lot 326.	18 1 shell. 1 4 fuse. 10 powder. 19 15	91	.....	.....
A. M.								
Dec. 28	1962	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	4 6	Shell, lot 326, altered for fuse.	18 3 shell. 10 powder, bursting charge. 1 3 fuse. 20 0	93	.....	.....
Dec. 28	1963	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	4 6	Shell, lot 326, altered for fuse.	18 1 shell. 10 powder, bursting charge. 1 3 fuse. 19 14	94	.....	.....
Dec. 28	1964	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	4 6	Shell, lot 326, altered for fuse.	18 4 shell. 10 powder, bursting charge. 1 3 fuse. 20 1	95	.....	.....
Dec. 28	1965	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	4 6	Shell, lot 326, altered for fuse.	18 2 shell. 10 powder, bursting charge. 1 3 fuse. 19 15	92	.....	.....

Watervliet Arsenal, at Sandy Hook, N. J., December 15 and 28, 1891.

sand was sufficient to cause ignition of bursting charge of shell without fuse.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet. 12	From rear 0°, 15 miles an hour.	Fuse base in housing, placed in bottom of cartridge bag, to test strength of base. Base depressed $\frac{1}{64}$ of an inch. Shell passed through box without breaking up, struck ground about 50 feet beyond, and ricocheted into woods; not recovered. Box badly broken.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired into box filled with sand; size 4 by 4 feet and 4 feet high; about 65 feet from gun.
16		All loose nuts on bolts in axle plate and flask of carriage tightened. Shell passed through box and recovered about 60 feet beyond. Box badly broken.	

with Merriam fuse.]

18	From rear 0°, 15 miles an hour.	Shell probably exploded after leaving box. First marks of fragments about 30 feet in rear of box. Box very badly broken, and no trace of explo sion within could be found.	Fuse with automatic delay. Arranged to explode at box after penetration. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
16		A screen 6 by 4 feet by 3 inches placed 6 feet in rear of box. Base and part of shell as far as rotating band red leaded. Shell burst after passing through screen, and probably very close to screen. Marks of explosion in sand about 7 feet behind box. Box and screen very badly broken.	
15	From rear 180°, 8 miles an hour.	Fuse of aluminum bronze. Shell passed through target and screen, making a clean hole in both. First marks of fragments found about 85 feet beyond target.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired into target 4 by 4 feet and 18 inches thick; 65 feet from gun; made of 3 layers of 2-inch plank and 4 layers of 3-inch plank. Screen 5 feet square and 1 inch thick; placed 14 feet in rear of target. Automatic delay. Arranged to explode on passing through target; rounds, 1,962 to 1,964, inclusive. Firing conducted by Lieut. C. B. Weeeler, Ordnance Department, assistant proof officer.
16		Fuse of console metal base, formerly fired as No. 07. Shell passed through target and screen, making a clean hole in both. First marks of fragments found 85 feet beyond target.	
16		Fuse of console metal. Shell passed through target, making a clean hole, and through screen, making e keyhole. First marks of fragments found about 75 feet beyond target.	
15		Fuse of aluminum bronze. Arranged to explode on striking target. Automatic delay cut out. Shell exploded between target and screen, demolishing screen.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, experiments with Merriam

Date.	No. of fire.	Powder.		Projectile.		No. of fuse.	Elevation.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs. Oz.*		° ′	*Pounds.*
A. M. Jan. 4.	1966	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 8	Shell, lot 326.	18 15 1 1 sand. 20 0	8	1 00	.....

[Object of firing, experiments

Ja . 8	1967	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 12	Shell, lot 326, altered for fuse.	18 2 shell. 10 rifle powder, bursting charge. 1 4½ fuse. 20 ½	96	.....	.....
Jan. 8	1968		4 12		18 2 shell. 10 rifle powder, bursting charge. 1 4½ fuse. 20 ½	97	.....	.....
Jan. 8	1969		4 12		18 2 shell. 10 rifle powder, bursting charge. 1 4½ fuse. 20 ½	98	.....	.....
Jan. 8	1970		4 12		18 2 shell. 10 rifle powder, bursting charge. 1 4½ fuse. 20 ½	99	.....	.....
Jan. 8	1971		4 12		18 0 shell. 10 rifle powder, bursting charge. 1 5 fuse. 19 15	100	.....	.....
Jan. 8	1972		4 12		18 1½ shell. 10 rifle powder, bursting charge. 1 5 fuse. 20 ½	101	.....	.....

Watervliet Arsenal, at Sandy Hook, N. J., January 4 and 8, 1892.

fuse to test strength of base.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
16	.....	Fuse base fired in housing placed in bottom of cartridge bag. Fuse base went in housing with difficulty, requiring two men to turn wrench. Fuse base recovered; depression $\frac{1}{64}$-inch.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired to sea. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.

with Merriam fuse.]

.....	From right and rear 45°, 6 miles an hour.	Target 24 inches thick. Fuse with automatic delay. Fuse base the one formerly fired as No. 08, console metal. Shell passed through target. First marks of fragments found 57 feet beyond.	
.....		Target 28 inches thick. Fuse with automatic delay. Shell passed through target. First marks of fragments found 57 feet beyond.	
.....		Target 28 inches thick. Fuse with automatic delay. Shell passed through target. First marks of fragments found 57 feet beyond.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired into target 65 feet from gun. Size of target 4 by 4 feet, made of spruce plank. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department.
.....		Target 28 inches thick and 8 by 8 inches spruce pieces put in front. Fuse with automatic delay. Shell passed through target. First marks of fragments found 39 feet beyond.	
.....		Target 3 inches thick. Fuse with automatic delay. Shell passed through target. First marks of fragments found 39 feet beyond.	
.....		Fuse with automatic delay cut out. Two screens, 4 by 4 feet and 3 inches thick, placed 8 feet apart, one to burst shrapnel, the other to ascertain point of bursting. Shell passed through both screens. First marks of fragments about 17 feet in rear of last screen.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, test

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	No. of fuse.	Elevation.	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*		° ′	*Pounds*
P. M. Jan. 19	1973	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 12	Shell, lot 326, altered for fuse.	18 8 shell. 10 rifle powder, bursting charge. 1 5 fuse. 20 7	102	.....	.....
Jan. 19	1974		4 12		18 2 shell. 10 rifle powder, bursting charge. 1 4 fuse. 20 0	103	.....	.....
Jan. 19	1975		4 12		18 2 shell. 10 rifle powder, bursting charge. 1 5 fuse. 20 1	104	.....	.....
Jan. 19	1976		4 12		17 14 shell. 10 rifle powder, bursting charge. 1 4 fuse. 19 12	105	.....	.....

[Object of firing, experiments

P. M. Jan. 28	1989	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 12	Shell, lot 326, altered for fuse.	18 5 shell. 10 rifle powder, bursting charge. 1 5 fuse. 20 4	106	.....	.....
Jan. 28	1990		4 12		18 3 shell. 10 rifle powder, bursting charge. 1 5 fuse. 20 2	107	.....	.....
Jan. 28	1991		4 12		18 1 shell. 10 rifle powder, bursting charge. 1 6 fuse. 20 1	108	.....	.....
Jan. 28	1992		4 12		18 1 shell. 10 rifle powder, bursting charge. 1 5 fuse. 20 0	111	.....	.....

Watervliet Arsenal, at Sandy Hook, N. J., January 19 and 28, 1892.

of Merriam fuse.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.	From rear 180°, 11 miles an hour.		
15		Target 16 inches thick. Shell passed through target and screen and burst. First marks of fragments in sand 33 feet behind screen.	
14		Target increased in thickness to 20 inches. Shell passed through target and screen and burst. First marks of fragments in sand 21 feet behind screen.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fuse with automatic delay made of console metal. Fired into target made of 4-inch plank, 65 feet in front of gun. Screen of 1-inch boards placed 20 feet in rear of target until moved back to 25 feet. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
15		Screen moved back to 25 feet from target. Target increased in thickness to 24 inches. Shell passed through target and burst between target and screen. First marks of fragments on ground 10 feet behind screen, and screen full of holes.	
15		Target increased in thickness to 28 inches. Shell passed through target and made large hole in bottom board of screen. First marks of fragments in sand 5 feet in rear of screen, showing that burst must have taken place near screen.	

with Merriam fuse.]

.....	From rear 180°, 13 miles an hour.	Target 40 inches thick. Screen of 1-inch boards placed 25 feet in rear of target. Shell passed through target, making a clean hole, and burst between target and screen. First marks of fragments on ground 25 feet from target.	
.....		Target made 51 inches thick. Screen of 1-inch boards placed 20 feet from rear of target. Shell passed through target, making a clean hole, and burst between target and screen. First marks of fragments on ground 14 feet behind target.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Fuse with automatic delay. Fired into target 65 feet from gun. Size 4 by 4 feet, made of 4-inch spruce plank. Cannon friction primers, model 1887. Fired to burst on striking target.
.....		Target 51 inches thick. Screen of 1-inch boards placed 10 feet from rear of target. Automatic delay valve taken out and space filled with powder. Shell burst in gun.	
.....		Target and screen same as last shot. Automatic delay cut out and automatic delay valve left in. Shell passed through target, making a clean hole, and burst just at rear of target, covering back of target with powder smoke.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

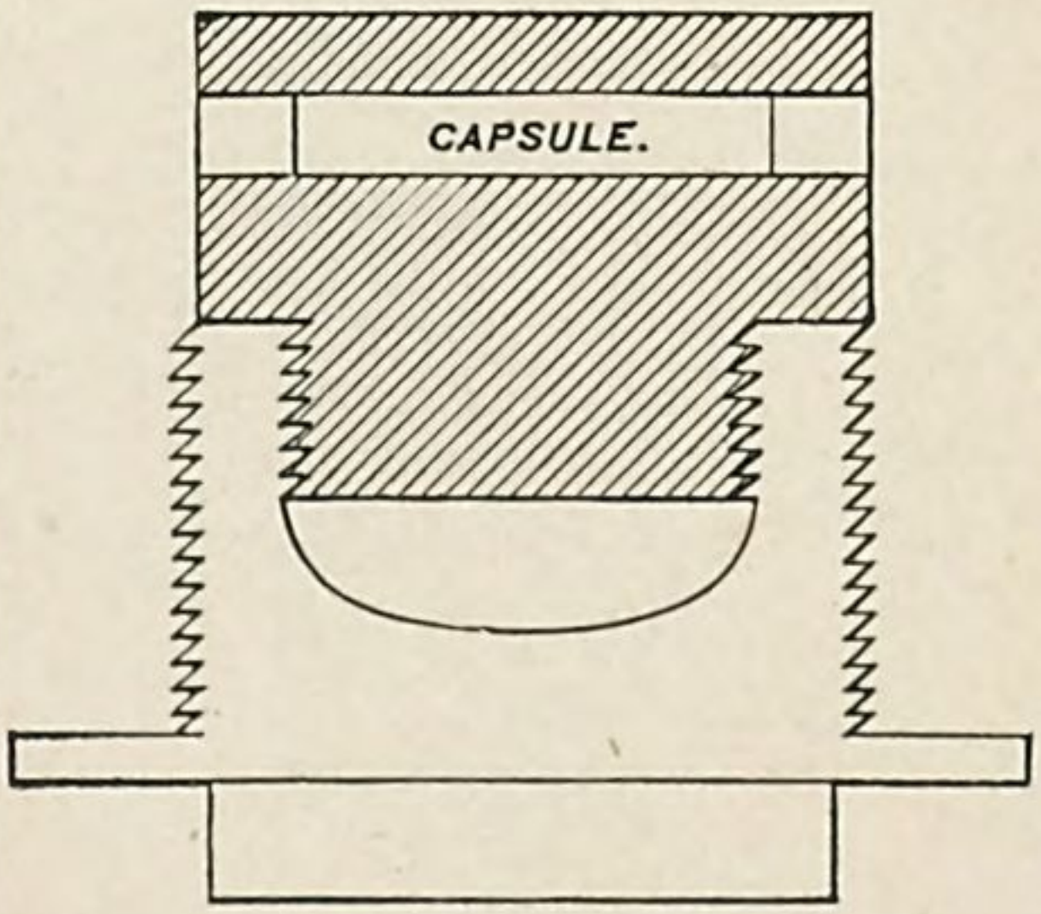
[Object of firing, to test effect of shock due to firing on fulminate of

	No. of fire.	Powder.		Projectile.		Number of housing.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		
			Lbs. Oz.		*Lbs. Oz.*		
P. M.	1993	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 12	Shell, lot 326, altered for fuse.	18 12 shell and housing.	.001	From rear 180°, 13 miles an hour.
	1994		4 12		19 1 shell and housing.	.002	

Watervliet Arsenal, at Sandy Hook, N. J., January 28, 1892.

mercury capsule in cylindrical copper case containing 10 grains.]

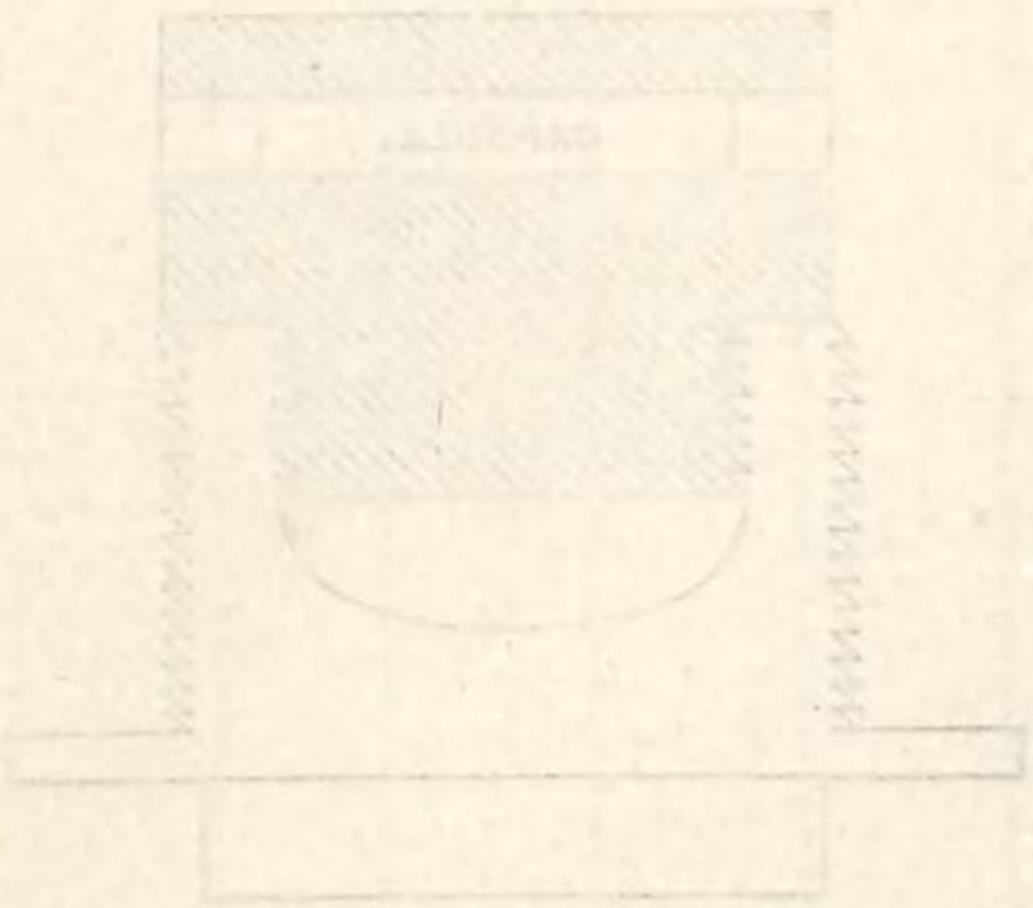
Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Housing for Merriam fuse used and solid piece of metal screwed into housing similar to part of fuse usually used. This solid piece had a cylindrical hole bored in it at right angles to axis of shell into which was placed capsule and the ends of hole plugged up. Diameter of hole just sufficient to enable capsule to be inserted. Shell recovered and examined. Capsule of fulminate had not been exploded.	Cannon friction primers, model, 1887. Fired into sand bank about 30 feet from gun. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
Housing, etc., same as before. Diameter of hole in metal piece slightly larger than diameter of capsule to enable capsule to be wound with two thicknesses of chamois skin to act as a cushion. Shell recovered and examined. Capsule of fulminate had not been exploded.	



Record of firing with 12-inch B. L. rifled mortar, No. 3 (cast iron),

[Object of firing, to

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	No. of fuse.	Pressure per square inch of bore.
			Lbs.		*Lbs. Oz.*	°		*Pounds.*
P. M.....	25	Du Pont's hexagonal M. W.; density, 1.725; granulation, 72.	22	Mortar shell, lot 329.	323 11 shell. 15 0 rifle powder, bursting charge. 1 5 fuse. 640 0	60	109	N. 8,750 O. 8,750
	26		22		621 3 shell. 15 0 rifle powder, bursting charge. 1 5 fuse. 637 8	60	110	N. 8,525 O. 8,200



Builders' Iron Foundry, at Sandy Hook, N. J., January 28, 1892.

test Merriam fuse.]

Recoil.	Wind. strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption or powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Inches. 10	Round 25 from rear and right 42°, 13 miles an hour. Round 26 from rear and right 10°, 13 miles an hour.	Fuse with automatic delay cut out. Escape of gas past pad. Shell struck the ground about 2,600 yards and burst. Diameter of crater 10 feet 8 inches; length of element. 7 feet; point of shell found in left side of crater, 4 feet from surface; fuse and part of base on right side, 3½ feet from surface; 23 fragments found in crater, lowest piece found 4½ feet from surface.	Mortar mounted on modified Krupp mortar carriage. Obturating friction primers. Chamber sponged out after each round. Fired down the beach. Uncompressed copper cylinders and tables of 1890.
10		Fuse with automatic delay. Spindle of mushroom head tightened before this round. Escape of gas past pad. Pad removed, canvas found cut over a length of about a quadrant on the edge. Shell struck the ground about 2,600 yards and burst. Diameter of crater, 10 feet; length of element, 6 feet 5 inches; point of shell found in left side of crater, 3 feet from surface; fuse and part of base in bottom of crater, 5 feet 3 inches from surface; 17 fragments of shell in crater.	Translating roller removed before each fire. Weight of largest fragment recovered, about 35 to 40 pounds. Weight of smallest fragment recovered, 1 pound or less. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.

MERRIAM'S BASE PERCUSSION FUZE
WITH AUTOMATIC DELAY

FIG. 2

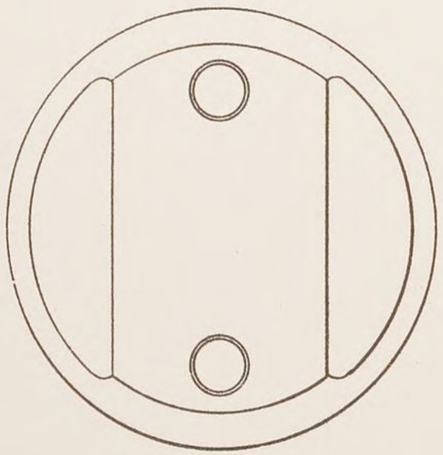


FIG. 1

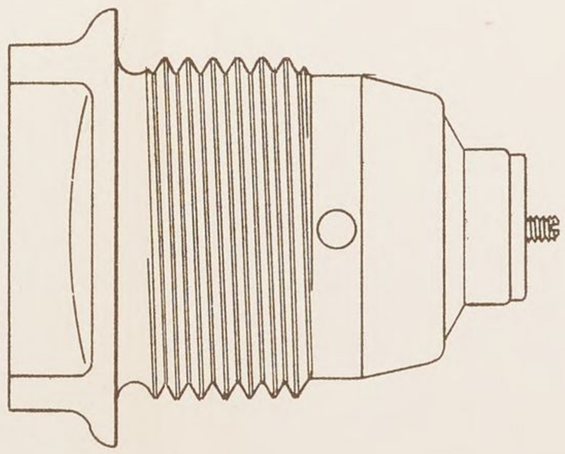


FIG. 3

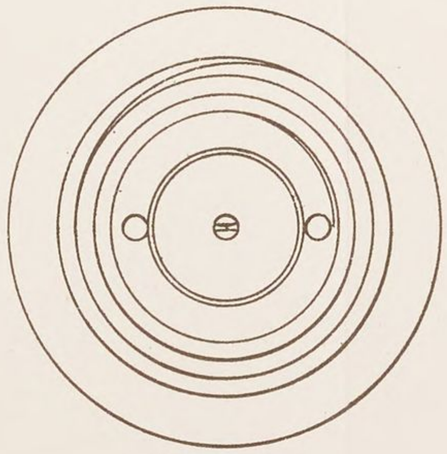


FIG. 9

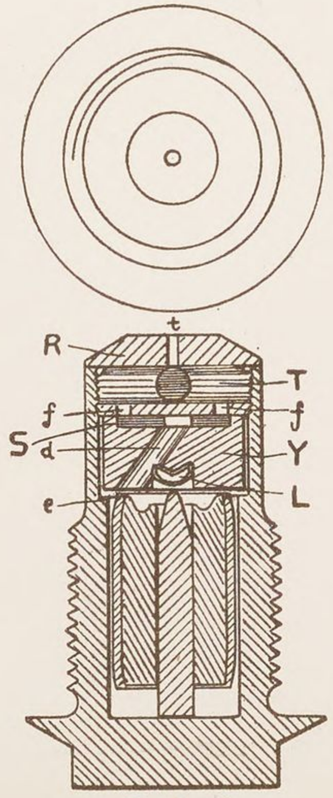


FIG. 8

FIG. 6

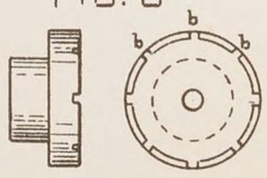


FIG. 7

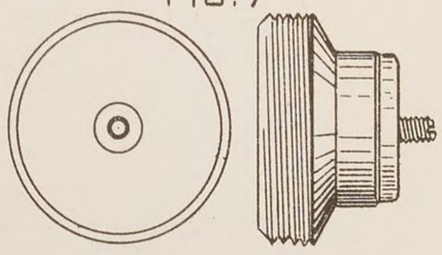


FIG. 4

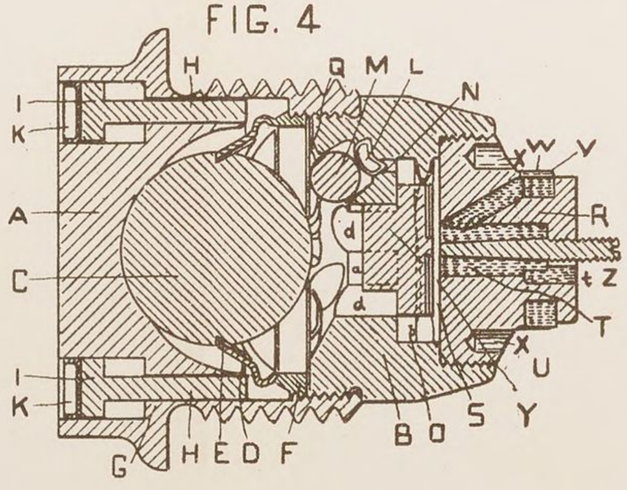
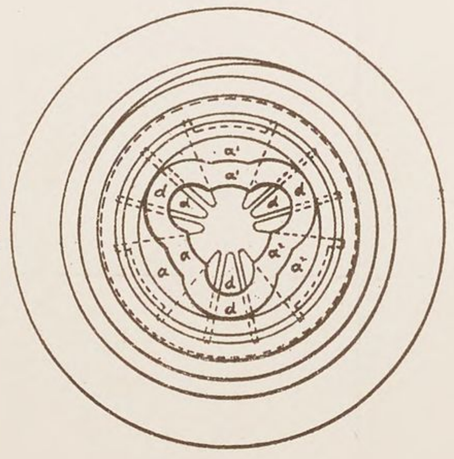


FIG. 5



Frank Heath

CAPTAIN ORDNANCE DEPT. U.S.A.

SANDY HOOK PROVING GROUND, FEB. 1ST 1892.

Fig. 10

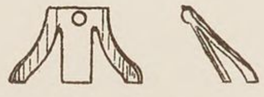
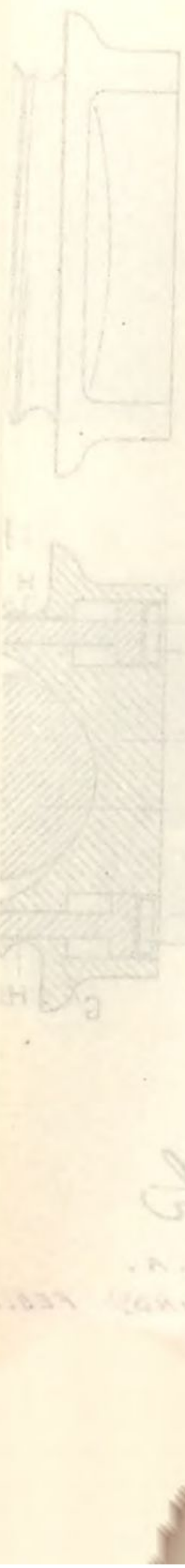


Fig. 11



APPENDIX 34.

PROGRESS REPORT ON MANUFACTURE OF STEEL FORGINGS, ETC., AT THE BETHLEHEM IRON WORKS, SOUTH BETHLEHEM, PA.

OFFICE OF INSPECTOR OF ORDNANCE, U. S. A.,
BETHLEHEM IRON WORKS,
South Bethlehem, Pa., July 29, 1892.

SIR: I have the honor to submit the following report of the progress during the fiscal year ending June 30, 1892, of the work ordered by the Ordnance Department to be made under the supervision of the inspector of ordnance at these works.

The Bethlehem Iron Company has continued work on the following orders, viz:

(1) Forgings for twenty-three 8-inch, twenty-three 10-inch, and fifteen 12-inch B. L. rifles.
(2) Forgings for ten 5-inch B. L. siege rifles.
(3) Twenty-four experimental steel shell for 12-inch B. L. mortars.
(4) Four steel armor plates for ballistic test of armor-piercing shot, fifty bolts and nuts, and one hundred washers.
(5) Eight side plates for erection of armor plates.
(6) Jacket casting for 10-inch wire wound B. L. rifle (Crozier).
(7) Forgings for 8-inch Haskell multicharge gun.
(8) Forgings for sixteen 3.6-inch field B. L. mortars.

They have also undertaken the following work under orders or contracts, viz:

(9) Jacket forging for 10-inch wire wound B. L. rifle (Crozier).
(10) Forty-five forgings for 7-inch shell bodies and five forgings for base plugs.
(11) Forged steel parts of barbette carriage for 12-inch B. L. rifle.
(12) Manufacture of twenty-five 8-inch, fifty 10-inch, and twenty-five 12-inch B. L. steel rifles.
(13) Miscellaneous forgings.

The trustees for the Brown segmental wire gun have undertaken to furnish under contract:

(14) One hundred projectiles for 5-inch Brown segmental tube wire gun.

Forgings for 8-inch, 10-inch, and 12-inch B. L. rifles.

Of the 8-inch forgings the delivery of the last four sets was completed during this year, the last forging due being accepted November 6, 1891.

Of the 10-inch forgings twelve sets were delivered during the year and of the 12-inch three sets were delivered.

Work has been prosecuted continuously on this contract during the year but not at a uniform rate, completed deliveries of several sets being made at about the same time, the last four of the 10-inch being completed in the same calendar month. But little trouble has been experienced in obtaining the desired characteristics in the metal except in some parts of the breech mechanism, and these cases are so few that it is believed the difficulties will be soon overcome and a certainty of delivery will then only be dependent on the extent of the plant devoted to meet the output required by the contract.

Forgings for ten 5-inch B. L. siege rifles.

Of these about one-half remained to be delivered at the beginning of this fiscal year, and the last delivery under the contract was on January 23, 1892.

Twenty-four experimental steel shell for 12-inch B. L. mortars.

Four shells shipped during the last year having been tested, a second lot of two having different qualities was ordered on December 17, 1891. Through inability to meet the requirements, and from other causes incidental to manufacture, this order had not been completed by June 30, 1892.

Four steel armor plates for ballistic test of armor-piercing shot and side plates for same.

The plates were presented for the selection of a trial plate on October 21, 1891. One $11\frac{1}{4}$-inch plate, with requisite bolts, nuts, and washers, also the eight side plates were shipped to Sandy Hook November 7, 1891. As a result of the ballistic trial the lot of plates were rejected on May 19, 1892, and up to the end of the year no action had been taken by the company toward submitting another plate for trial, they awaiting a reconsideration of the rejection.

Jacket casting for 10-inch wire wound B. L. rifle (Crozier).

The jacket was cast October 27, 1891, but blow holes having been developed in boring to required size, the casting was rejected.

Jacket forging for 10-inch wire wound B. L. rifle (Crozier).

In view of the futile attempts to obtain a sound steel casting an order was given January 16, 1892, to manufacture a jacket forging having 70,000 pounds tensile strength, 35,000 pounds elastic limit, and 12 per cent elongation. Owing to the selection of an unsuitable ingot the desired qualities have not yet been fully met, although work has been prosecuted under the order for several months.

Forgings for forty-five 7-inch shell bodies and five forgings for base plugs.

This contract was dated July 9, 1891, and all the forgings were delivered on September 24, 1891.

Forgings for 8-inch Haskell multicharge gun.

Under this contract twenty-three forgings, whose total weight was 84,983 pounds, have been inspected and accepted by Mr. J. R. Haskell and have been received by the Department and shipped to the Reading Iron Company, Reading, Pa.

Manufacture of B. L. steel rifles.

This contract has been signed and dated November 7, 1891. No work has yet been done on the guns, but an extension of the present plant has been in progress for some months.

Forgings for 3.6-inch B. L. field mortars.

These forgings, which were due December 8, 1891, were all delivered by December 30, 1891. But little difficulty was met in obtaining desired qualities.

Forged steel parts of barbette carriage for 12-inch B. L. rifle.

These forgings were ordered from Watertown Arsenal in June. No work has yet been done.

Miscellaneous.

The following miscellaneous pieces have been furnished or are under way, viz:

One pinion for 12-inch B. L. rifle. Delivered January 19, 1892.
Ten steel plates for manufacture of Belleville springs. Delivered September 17, 1891.
One 8-inch breech plate. Delivered August 7, 1891.
One 5-inch trunnion hoop. Delivered January 19, 1892.
Five 5-inch spindles. Delivered January 19, 1892.
One 10-inch trunnion hoop. Delivered March 26, 1892.
One 5-inch trunnion hoop. Delivered June 9, 1892.
One breech plug for 5-inch rifle (Seabury breech mechanism). Delivered September 2, 1891.
One 12-inch trunnion hoop.
One 12 inch breech block.
One 8-inch spindle.
One 3.6-inch field B. L. mortar breechblock.

Projectiles for 5-inch Brown segmental tube wire gun.

These are to be delivered under contract by the trustees of the Brown gun. No work has yet been done.

The following table gives the average physical qualities of specimens tested from material furnished during the year:

Designation of piece.	Number of pieces.	Average.			
		Elastic limit per square inch of original section.	Tensile strength per square inch of original section.	Elongation after rupture.	Reduction in area after rupture.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
10-inch tubes	13	47,100	91,500	21.1	44.4
10-inch jackets	12	49,100	94,400	19.9	42.0
10-inch trunnion hoops	13	55,860	105,700	16.1	38.6
10-inch A hoops	36	58,000	105,000	16.9	43.1
10-inch B hoops	20	58,380	105,800	16.9	43.0
10-inch C hoops	47	57,100	104,840	17.1	40.3
10-inch D hoops	15	57,800	105,420	16.5	41.9
10-inch breechblocks	8	48,750	90,875	19.1	36.0
10-inch spindles	9	50,000	91,300	19.6	38.6
10-inch hinge pins	4	57,500	102,000	18.1	46.7
10-inch gas check cups	10	80,600	149,960	11.3	22.8
10-inch securing pins	12	89,000	143,400	13.9	36.4
12-inch tubes	6	46,960	89,960	21.3	45.2
12-inch jackets	5	48,354	94,200	19.6	42.6
12-inch trunnion hoops	8	55,100	106,200	15.1	36.5
12-inch A hoops	10	57,300	104,760	16.6	43.7
12-inch B hoops	8	57,340	104,170	17.2	44.2
12-inch C hoops	21	58,200	103,400	16.5	42.1
12-inch D hoops	5	58,100	106,200	16.1	42.1
12-inch breechblocks	1	49,500	94,400	17.7	38.2
12-inch hinge pins	4	55,800	87,200	23.3	56.4
12-inch translating rollers	5	57,000	97,400	21.0	53.0
12-inch gas check cups	3	81,500	151,900	11.4	24.6
12-inch securing pins	9	83,400	148,700	15.2	37.1
3.6-inch mortar bodies	16	51,400	94,500	21.5	38.2
3.6-inch mortar breech blocks	2	49,000	90,250	22.2	41.4
3.6-inch mortar spindles	2	58,000	91,000	27.6	65.7
3.6-inch mortar gas check rings	3	82,000	153,000	13.1	19.4
7-inch shell bodies	6	41,200	76,200	18.5	26.3

This table shows the excellence of the material which has been obtained for the manufacture of our high-power rifles of larger caliber. In every case the average far exceeds the required quality, and, with the tubes, jackets, and mortar bodies, it is even beyond that which it was desired the manufacturer should endeavor to obtain. Furthermore the average qualities of the different hoops, both for the 10-inch and 12-inch rifles, indicate by their similarity a very desirable evenness of production.

The weights of the forgings shipped during the year are as follows:

Forgings for—	Weight.
	Pounds.
5-inch B. L. rifle	29,008
8-inch B. L. rifle	86,208
10-inch B. L. rifle	1,029,366
12-inch B. L. rifle	664,000
3.6-inch field B. L. mortar	5,340
8-inch Haskell multicharge gun	84,983
7-inch shell bodies and base plugs	6,884
Plates, bolts, nuts, and washers	52,602
Total	1,960,473

Very respectfully, your obedient servant,

I. MACNUTT,
Captain, Ord. Dept., U. S. Army, Inspector.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

(3889–'92.)

APPENDIX 35.

PROGRESS REPORT ON THE MANUFACTURE OF STEEL FORGINGS, ETC., AT THE MIDVALE STEEL WORKS, PHILADELPHIA, PA.

MIDVALE STEEL WORKS,
Philadelphia, Pa., October 1, 1892.

SIR: I have the honor to transmit the following report upon the operations undertaken for the Ordnance Department, U. S. Army, by the Midvale Steel Company for the fiscal year ending June 30, 1892.

All information relative to manufacture is omitted from this report upon the request of the Midvale Steel Company. The right to make this request is granted in the specifications embodied in the contracts, and all information given by the company is to be considered as confidential and for the use of the Department only:

List of fabrications.

Date of order or contract.	Date of expiration of contract or extension of contract.	No. of contract.	Fabrication.
Dec. 1, 1890	Jan. 2, 1893	1	43 sets of steel forgings for 12-inch B. L. R. mortars (cast-iron body).
June 15, 1891	Aug. 16, 1896	2	9 sets of steel forgings for 12-inch B. L. rifle.
June 15, 1891	July 16, 1894	3	14 sets of steel forgings for 10-inch B. L. rifle.
June 15, 1891	Aug. 16, 1892	4	12 sets of steel forgings for 8-inch B. L. rifle.
Sept. 19, 1892	Aug. 1, 1893	5	10 sets of steel forgings for 8 inch B. L. rifle.
Sept. 14, 1892	June 14, 1893	6	10 sets of steel forgings for 7-inch B. L. R. siege howitzer.
Sept. 14, 1892	Dec. 14, 1893	7	1 set of steel forgings for 7-inch B. L. R. siege mortar.
Sept. 14, 1892	June 28, 1893	8	10 sets of steel forgings for 5-inch B. L. R. siege guns.
Mar. 10, 1892	June 14, 1892	9	24 sets of steel forgings for 3.6-inch B. L. R. field guns.
Sept. 14, 1892	Apr. 14, 1893	10	25 sets of steel forgings for 3.2-inch B. L. R. field guns.
Dec. 13, 1890	Dec. 13, 1891	11	218 8-inch armor-piercing steel shot (extended to December 6, 1892).
Dec. 13, 1890	June 5, 1892	12	217 10 inch armor-piercing steel shot (extended to December 6, 1892).
June 8, 1891	Mar. 11, 1892	13	100 8-inch armor-piercing steel shot.
June 8, 1891	Dec. 4, 1892	14	205 10-inch armor-piercing steel shot.
June 8, 1891	Aug. 1, 1892	15	50 12-inch armor-piercing steel shot.
Apr. 11, 1892	May 2, 1892	16	25 12.2-inch mortar shell; 5 bars for base plugs.
July 22, 1892	Immediate...	17	100 5-inch projectiles for 5-inch Brown's segmental wire-wound gun.
Feb. 8, 1892	....do	18	1 set of steel forgings for 8-inch disappearing carriage.
Sept. 12, 1892	....do	19	1 set of steel forgings for 10-inch disappearing carriage.

MISCELLANEOUS STEEL FORGINGS.

Aug. 21, 1891	Immediate...	20	2 gun-steel shaft forgings for disappearing carriage, ordered by Morgan Engineering Company.
Nov. 17, 1891	....do	21	1 12-inch mortar face plate; 2 12-inch mortar pinions; 1 disk for 12-inch mortar breechblock, ordered by Builders' Iron Foundry.
Dec. 10, 1891	....do	22	1 12-inch spindle, extra length of head (4-inch instead of 3½-inch), ordered by Builders' Iron Foundry.
May 9, 1892	....do	23	1 12-inch spindle to replace condemned spindle.
June 3, 1892	....do	24	1 12-inch spindle to replace condemned spindle.
Aug. 17, 1892	....do	25	1 12-inch face plate to replace one condemned in machining.
Jan. 9, 1892	....do	26	3 rings, outside diameter, 39 inches; inside, 31⅓; length, 4¾ inches, ordered by Benjamin Atha & Illingworth Company for Morgan Engineering Company.
Feb. 1, 1892	....do	27	1 3.2-inch spindle for Gerdom breech mechanism, ordered by Watervliet Arsenal.
July 23, 1892	....do	28	1 3.2-inch spindle for Gerdom rifle; 2 3.2-inch gas checks for Gerdom rifle, ordered by New York Arsenal.
Apr. 11, 1892	....do	29	1 axle for 7-inch howitzer carriage, ordered by New York Arsenal.

List of fabrications—Continued.

STEEL CASTINGS.

Date of order or contract.	Date of expiration of contract or extension of contract.	No. of contract.	Fabrication.
June 8, 1891	Sept. 28, 1891	30	16 sets for 3.6-inch field mortar carriage.
Aug. 21, 1891	Immediate...	31	4 crank castings, ordered by Morgan Engineering Company.
Dec. 3, 1891	....do	32	1 set of castings for 8-inch disappearing carriage, ordered by Southwark Foundry and Machine Company.
Dec. 12, 1891	....do	32	
Jan. 6, 1892	....do	32	
Feb. 18, 1892	....do	32	
Jan. 11, 1892	....do	33	1 lot of castings for 12-inch barbette carriage for Watertown Arsenal.
Apr. 13, 1892	....do	33	
Apr. 19, 1892	....do	34	1 chain wheel, 1 worm gear, 1 segmental gear for 8-inch barbette carriage, ordered by Watertown Arsenal.
Aug. 3, 1892	....do	35	1 set of castings for 10-inch disappearing carriage, ordered by Southwark Foundry and Machine Company.
Aug. 22, 1892	....do	35	
Sept. 1, 1892	....do	35	
Sept. 8, 1892	....do	35	

Of the above list the following numbers have been completed: Nos. 1, 9, 16, 17, 18, 21, 22, 23, 24, 25, 26, 27, 28, 29, and 34.

The stores represented by these numbers have all been shipped to their respective destinations.

The unfinished work at the date of this report comprises Nos. 2, 3, 4, 5, 6, 7, 8, 10, 11, 12, 13, 14, 15, 19, 30, 32, 33, and 35.

The orders for the work represented by Nos. 20 and 31 were canceled by the Morgan Engineering Company before the manufacture was begun.

Of the unfinished work Nos. 4, 19, 32, and 33 are nearly completed.

No work has yet been submitted for test from Nos. 2, 5, 7, 11, 12, 13, 14, and 15.

The work under Nos. 3, 6, 8, 10, 30, and 35 is in progress at the date of this report.

References to the finished and unfinished work will be given below under appropriate headings.

I.—*12-inch B. L. rifled mortars (with cast-iron bodies).*

Contract of December 1, 1890. This contract was for 43 sets of forgings, and at the date of the last annual report 136 cylindrical hoops and several trunnion hoops remained unfinished. All the forgings except 3 trunnion hoops and 2 A_5 hoops were completed by December 31, 1891.

The entire contract was completed on January 21, 1892, or nearly one year in advance of its expiration. This contract expires January 2, 1893.

II.—*12-inch B. L. rifles.*

This contract is for 8 guns, model of 1888, and 1 gun, model of 1891. Preparatory work has been done, and the forgings for the breech mechanism are just about to be made, and will probably be completed by the end of the calendar year.

III.—*10-inch B. L. rifles.*

Fourteen 10-inch B. L. rifles are to be made under this contract. The following forgings have already been made and most of them have been shipped, viz:

Twelve rotating rings, 12 compound gears, 36 securing pins, 12 hinge pins, 12 rear gas checks, 12 front gas checks, 9 spindles, 5 breechblocks, 1 hoop D_2, 10 hoops C_3, 11 hoops C_4, 10 hoops C_5.

The breaking of the tup of the large steam hammer has delayed all heavy work, or the first three sets of these forgings would have been well advanced if not completed.

IV.—*8 inch B. L. rifles.*

(*a*) Contract of June 15, 1891. Twelve sets of forgings are called for under this contract, and the last delivery was due August 16, 1892, and would probably have been made had it not been for the unfortunate accident which disabled the large steam hammer on July 25, 1892. Only six pieces remain to be finished under this order, and of these five are yet to be forged, viz: One tube, 1 jacket, and 1 each of the A_3, A_4, and A_5 hoops. The last trunnion hoop is now ready for treatment. The repairs on the hammer are nearly completed, and the few forgings yet required will be made as soon as possible. The 8-inch forgings will be completed before the end of the calendar year.

(*b*) Contract of September 19, 1892. Ten sets are required for this contract. No work has yet been done.

V.—*Siege pieces.*

(*a*) Ten sets of forgings for 7-inch B. L. rifled siege howitzer, (*b*) one set of forgings for 7-inch B. L. rifled siege mortar, (*c*) ten sets of forgings for 5-inch B. L. rifled siege rifle, contract of September 14, 1892. Work has just begun upon these forgings, and should no unforeseen delay occur they should all be completed within the contract time.

VI.—*Field pieces.*

(*a*) Twenty-four sets of steel forgings for 3.6-inch B. L. rifled field guns. The contract for these forgings was dated March 10, 1892, and expired June 14, 1892. The forgings were all finished and the last of these delivered for inspection on June 14, 1892, but two tubes were rejected. The specifications allow one month to replace rejected pieces of this character, which extended the time to July 14, 1892. The tubes were replaced on that date.

(*b*) Twenty-five sets of steel forgings for 3.2-inch B. L. rifled field guns. The date of this contract is September 14, 1892. The company is at work upon these guns and will probably deliver them on time.

VII.—*Armor-piercing projectiles.*

(*a*) Two hundred and eighteen 8-inch armor-piercing shot, (*b*) two hundred and seventeen 10-inch armor-piercing shot (contract extended to December 6, 1892), (*c*) one hundred 8-inch armor-piercing shot, (*d*) two hundred and five 10-inch armor-piercing shot, (*e*) fifty 12-inch armor-piercing shot (contract will expire December 4, 1892). The erection of the plant to manufacture these Holtzer projectiles is now about finished, and the company hopes to proceed with the work without delay. The delay has been due to the tardy arrival of the plans and specifications from France.

VIII.—*Forgings for 12.2-inch mortar shell.*

Twenty-five blanks or rough-finished forgings for 12.2-inch mortar shell were due under this contract.

Specifications.—The shell to be made of open-hearth steel, forged, annealed, and rough finished to blue print sketch. Tests: One 2-inch

specimen from every fifth body after annealing and at least one body from each heat. Tensile strength not less than 65,000 pounds per square inch. Elongation, 15 per cent.

Results of tensile tests.

Midvale number.	United States marks.	Elastic limit.	Tensile strength.	Elongation.	Contraction.	Accepts.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*	
S—6295	12″.2 M R 1 S H—T_1M.	35,500	73,500	19.00	34.40	Nos. 1, 2, 3.
6296	12″.2 M R 4 S H—T_1M.	37,000	75,000	21.80	27.85	4, 5, 6.
6299	12″.2 M R 7 S H—T_1M.	43,000	79,500	19.50	34.40	7, 8, 9.
6571	12″.2 M R 10 S H—T_1M.	32,500	69,500	23.20	27.51	10, 11, 12.
6574	12″.2 M R 13 S H—T_1M.	39,500	75,500	23.00	31.80	13, 14, 15.
6572	12″.2 M R 16 S H—T_1M.	34,000	69,000	12.50	15.92	Withdrawn and retreated.
	T_2M.	34,000	67,000	13.00	16.32	
	T_3M.	32,500	69,000	17.50	18.82	Nos. 16, 17, 18.
6573	12″.2 M R 19 S H—T_1M.	38,000	75,000	17.50	32.45	19, 20, 21.
6575	12″.2 M R 24 S H—T_1M.	40,000	79,000	20.00	30.85	22, 23, 24.
6767	12″.2 M R 25 S H—T_1M.	41,500	77,000	18.70	33.10	No. 25.

Of the five bars for base plugs Nos. 1, 2, 3, and 4 were passed on tests of S–6299 from the same heat, and No. 5 on test of S–6767, both from the same heat.

Principal dimensions and weights.

12.2-inch mortar shell bodies:

Total length	inches..	48.225
Body, cylinder—		
Length	do....	33.585
Diameter	do....	12.325
Head, ogee—		
Length	do....	12.675
Diameter	do....	12.2
Radius	do....	18.3
Point, cylinder—		
Length	do....	1.965
Diameter	do....	2.0
Weight	pounds..	1,394.3
Bars for base plugs—		
Length	inches..	17.25
Diameter	do....	8.4375
Weight	pounds..	273

The last of these bodies was shipped to Watervliet Arsenal June 15, 1892.

IX.—*5-inch projectiles for Brown segmental wire-wound gun.*

The only work done at Midvale Steel Works upon these projectiles was to furnish the blanks, or forged bodies from which the projectiles are to be turned. The contract calls for 100 projectiles.

Specifications.—The specifications prescribe—

That the said projectiles shall be turned and bored from annealed bars of open-hearth steel, each bar to be of sufficient length for ten projectiles. The bars are to be tested by taking one longitudinal test specimen from each bar, 2 inches in length between shoulders, and 0.505 inch in diameter. These specimens must show the following physical qualities, viz:

Tensile strength	pounds per square inch..	70,000
Elastic limit	do....	35,000
Elongation after rupture	per cent..	12

The ten bars required for the 100 projectiles were made from four heats of metal, two bars from each heat, except the last, which furnished four bars.

Results of tensile tests.

[For 100 bodies for 5-inch Brown projectiles.]

Number.	Marks.	Elastic limit.	Tensile strength.	Elongation.	Contraction.	Accepts.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*	
S—6943	5 R 1 P—L_1	40,250	75,100	31.40	51.67	1 to 10 inclusive.
6944	5 R 11 P—L^1	40,000	75,000	30.50	52.77	11 to 20 inclusive.
7510	5 R 21 P—L_1	44,000	87,000	20.50	40.69	21 to 30 inclusive.
7511	5 R 31 P—L_1	45,500	86,000	25.60	48.32	31 to 40 inclusive.
7512	5 R 41 P—L_1	45,500	86,500	21.00	33.45	41 to 50 inclusive.
7513	5 R 51 P—L_1	45,000	87,000	24.80	42.78	51 to 60 inclusive.
7623	5 R 61 P—L_1	48,000	88,000	23.10	43.68	61 to 70 inclusive.
7624	5 R 71 P—L_1	44,000	86,500	25.20	46.88	71 to 80 inclusive.
7625	5 R 81 P—L_1	45,500	85,000	29.00	51.97	81 to 90 inclusive.
7626	5 R 100 P—L_1	45,000	85,250	30.40	50.57	91 to 100 inclusive.

After testing the annealed bars were turned and then cut up into lengths.

Cylindrical body:
Length ..... inches.. 17
Diameter ..... do.... 5½
Weight ..... pounds.. 100
Number of bodies 100

The cylindrical bodies were shipped to the Pennsylvania Diamond Drill Manufacturing Company, of Birdsboro, Berks County, Pa., for machining.

X.—*Steel forgings for 8-inch disappearing carriage.*

The order for this set of steel forgings came from the Southwark Foundry and Machine Company, of Philadelphia, Pa.

The following is a list of the forgings furnished under this order, viz:

From steel, grade No. 3: Two piston rods, 22 rollers, 18 conical rollers, 1 rotating arm axle, 2 elevating rods, 4 caps, 1 suspension rod shaft.
From steel, grade No. 2: Four piston rod nuts.
From steel, grade No. 1: Twenty-two roller axles, 4 axles, 4 axle collars, 2 chain pulley axles, 1 shaft, 2 chain pulleys, 1 worm wheel, 1 elevating shaft, 1 traversing shaft, 2 counter shafts, 2 suspension rods.
Total, 96 forgings.

Representative treatment was employed wherever practicable to reduce the number of tests and to save time. The physical tests will be found in one of the tables forming part of the appendix to this report. All these pieces have been shipped to the Southwark Foundry and Machine Company.

XI.—*Steel forgings for 10-inch disappearing carriage.*

The order for this set of forgings also came from the Southwark Foundry and Machine Company. The following is a list of the steel forgings ordered to date, viz:

From steel, grade No. 3: One suspension rod shaft, 2 elevating rods (right and left), 2 piston rods, 24 top carriage rollers, 4 elevating rod caps, 20 conical rollers, 1 rotating arm axle.
From steel, grade No. 2: Two suspension rods, 4 piston rod nuts, 2 elevating racks (right and left), 24 roller axles, 1 worm wheel shaft, 2 chain pulley axles, 2 elevating gear countershafts, 1 elevating through shaft, 1 traversing worm shaft, 2 elevating rack stops, 2 elevating rack pins, 2 chain pulleys, 2 locking shafts, 8 locking wheel handles, 2 locking nuts, 1 spanner wrench, 2 rear traverse wheel axles, 4 axle collar forgings, 1 collar, 1 traveling worm.
Total, 122 steel forgings.

All these forgings except the rotating-arm axle have been fabricated, tested, and shipped to the Southwark Foundry and Machine Company. The tests will be found in the appendix.

XII.—*Miscellaneous steel forgings.*

(*a*) One 12-inch mortar face plate, two 12-inch mortar pinions, one disk for 12-inch mortar breechblock ordered November 17, 1891; shipped December 16, 1891. The above forgings were ordered by the Builders' Iron Foundry, Providence, R. I., to replace pieces spoiled in machining. The face plate and pinions were forged and treated at the same time, the former alone being tested. The breechblock disk was cut from the excess of metal on one of the 12-inch breechblocks after the block had been tested. The test of the face plate gave the following results:

Number.	Marks.	Elastic limit.	Tensile strength.	Elongation.	Contraction.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
N—2079	12 M R 74 F P—T_1 M....	55,000	90,800	25.20	56.96

(*b*) One 12-inch mortar spindle, with head 4 inches long instead of 3½ inches long, ordered December 10, 1891; shipped February 26, 1892. This was a spindle with an extra length of head ordered by the Builders' Iron Foundry. The first spindle made for this order was by error cut to the regular length of head, and was shipped January 23, 1892. The error was discovered at Providence and the spindle returned. The tensile tests of the spindle sent to fill this order gave the following results:

Number.	Marks.	Elastic limit.	Tensile strength.	Elongation.	Contraction.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
N—3090	12 M R 78 S P—T_1 O....	51,000	92,400	19.40	49.20
	T_2 M....	49,000	91,280	18.53	39.41

(*c*) One 12-inch mortar spindle, ordered May 9, 1892, shipped immediately; one 12-inch mortar spindle, ordered June 3, 1892, shipped July 26, 1892. These two spindles were made to replace two spindles condemned in machining at Providence, R. I. The tests were as follows:

Number.	Marks.	Tensile strength.	Elastic limit.	Elongation.	Contraction.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
N—3092	12 M R 77 S P—T_2 O....	49,000	90,800	24.40	50.96
	T_3 M....	46,000	90,800	24.00	49.96
S—6886	12 M R 79 S P—T_1 O....	56,000	92,800	21.10	48.18

(*d*) One 12-inch mortar face plate; ordered August 17, 1892; shipped September 21, 1892. This face plate was made to replace one condemned at Providence for seams developed in machining. Test:

Number.	Marks.	Tensile strength.	Elastic limit.	Elongation.	Contraction.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
S—7855	12 M R 75 F P—T_1 M....	52,000	88,000	18.00	33.76

(*e*) Three cylindrical rings. These rings were ordered by the Benj. Atha & Illingworth Company for the Morgan Engineering Company, of Alliance, Ohio. They were rolled the same as mortar hoops, and subjected to representative treatment. Tests are as follows:

Marks.	Tensile strength.	Elastic limit.	Elongation.	Contraction.
	Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
T_1 O	41,000	81,000	30.40	50.73
T_2 M	39,000	80,000	29.20	49.17
T_3 I	41,500	82,000	28.20	50.57

Dimensions.

Exterior diameter	inches	39
Interior diameter	do	$31\frac{1}{2}$
Length	do	$4\frac{3}{4}$
Number		3

(*f*) One 3.2-inch spindle ordered by Watervliet Arsenal February 1, 1892; one 3.2-inch spindle ordered by New York Arsenal July 22, 1892; two 3.2-inch gas checks ordered by New York Arsenal July 22, 1892. These forgings were ordered for the Gerdom breech mechanism. The spindle for Watervliet Arsenal was shipped February 29, 1892. The tests gave the following results:

Number.	Marks.	Tensile strength.	Elastic limit.	Elongation.	Contraction.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
S—4797	32 R 126 S P—L_1 M	53,000	90,000	26.40	58.56

The spindle and two gas checks ordered by New York Arsenal were shipped to the commanding officer ordnance proving ground, Sandy Hook, New Jersey, on August 9, 1892. The results of the physical tests were:

Number.	Marks.	Tensile strength.	Elastic limit.	Elongation.	Contraction.
		Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
For spindle: S—7321	32 R S P X– L_1 M	55,000	91,000	29.20	61.11
For gas checks: S—7325	32 R G C—T_1 M	84,000	142,000	14.50	35.70

(*g*) One axle for 7-inch howitzer carriage. This axle was ordered April 11, 1892, by the New York Arsenal. It was forged, treated, and tested at each end.

Result of tests.

Marks.	Tensile strength.	Elastic limit.	Elongation.	Contraction.
	Pounds.	*Pounds.*	*Per cent.*	*Per cent.*
N Y 1 A X—L_1 O	43,500	80,500	27.20	53.87
N Y 1 A X—L_1 A	47,500	80,500	32.70	55.21

The forgings were shipped to New York Arsenal.

XIII.—*Steel castings.*

(*a*) Sixteen sets steel castings for 3.6-inch field-mortar carriage. This contract expired September 28, 1891. All the castings were completed at that date, but part of them were not inspected until a few days later, when 1 elevating arc and 3 carriage frames were rejected for holes in castings. A lot of the castings were afterwards condemned at Watervliet Arsenal for developed defects, which brought the whole number to be replaced up to 13 carriage frames and 12 elevating arcs. The company had less success with these castings than with any others they have undertaken. Over 50 carriage frames have been cast to date, of which number 11 have been provisionally accepted. There yet remain to be replaced 5 carriage frames and 3 elevating arcs. I have urged the completion of these castings every week since my last report. There is a faint prospect of their completion before the end of the calendar year.

(*b*) One set of steel castings for 8-inch disappearing carriage, ordered by Southwark Foundry and Machine Company. These castings were ordered in lots and the inspector was at first not notified of the orders, hence the dates are given only in cases where known.

List of 8-inch castings ordered:

December 3, 1891, 2 rotating arms, 1 transom, 1 wheel bracket, 4 traverse wheels, 2 caps for rotating arms.

December 24, 1891, 1 upper roller path, 1 lower roller path, 4 segments, traversing circle, 2 pivot-bearing caps.

January 6, 1892, 2 chassis rails, 2 cylinder heads, 2 clips.

February 18, 1892, 2 hydraulic cylinders.

No date, 1 reservoir cap, 1 cap, 2 elevating bands, 1 ratchet wheel, 1 pawl, 2 spur wheels, 1 chain pulley.

Total, 35 castings.

All these castings have been shipped, except the two spur wheels and chain pulley, which were condemned for blow-holes. The two rotating arms first cast were afterwards rejected for cavities developed in machining, and were replaced.

(*c*) Two lots of steel castings for Watertown Arsenal.

First. Castings for 8-inch barbette carriage: One chain wheel, 1 worm gear, 1 segmental gear, ordered April 19, 1892; shipped July 14, 1892. The above were to be made from cast steel, No. 1, to be annealed at about 1,500 degrees, and show a tensile strength of 65,000 pounds per square inch and elongation of 20 per cent. The only available place for a specimen was from the riser, unless a separate coupon was cast. The specimen from the riser showed elastic limit 33,000 pounds, tensile strength 65,000 pounds, elongation 15 per cent, contraction 23.41 per cent, and betrayed evidences of the drawing of the metal, usual in such cases, which accounts for the low elongation.

Second. Castings for 12-inch barbette carriage:

January 11, 1892, 1 top carriage, 2 cheeks, 1 upper roller path.

April 13, 1892, 2 caps, 2 cylinder glands, 2 reservoir cylinder heads, 1 bearing for elevating shaft, 1 bearing for traveling worm.

All the above castings have been shipped, except the top carriage and the upper roller path.

(*d*) One lot of steel castings for 10-inch disappearing carriage, ordered by Southwark Foundry and Machine Company. The following list gives the date of order and the designation of the pieces:

August 3, 1892, 2 rotating arms, 2 hydraulic cylinders, 2 chassis, 1 bracket, rear traverse wheel, 1 upper roller path, 1 lower roller path, 1 elevating rod truss, 2 hy-

draulic cylinder heads, 4 elevating rack guides, 2 roller path clips or guides, 2 rifle trunnion bearing caps, 1 transom.

August 22, 1892, 4 segments, rear traversing circle, 2 crossheads, 1 elevating band.

September 1, 1892, 2 pivot-bearing caps, 4 rear traverse wheels, 1 traversing gear bracket, 1 traversing chain wheel, 2 spur wheels.

Total, 38 steel castings.

Of the above list the following have been shipped to the Southwark Foundry and Machine Company, viz:

One rotating arm, 1 hydraulic cylinder, 1 bracket for rear traverse wheel, 1 elevating rod truss, 4 elevating rack guides, 2 roller path clips, 2 rifle trunnion bearing caps, 2 crossheads, 1 traversing gear bracket, 1 traversing chain wheel.

Total, 16 steel castings shipped.

The two spur wheels were cast, but were condemned for blow-holes. It is hoped to finish this order in the near future.

Remarks.

The Midvale Steel Company experienced many vexatious and unavoidable delays during the year, due to untimely accidents and the failure of contractors to finish the work on various parts of the plant on time. The coming year it is expected to turn out the work more rapidly. On the whole the company has made satisfactory progress on ordnance work. The tensile tests of material will be found tabulated in the appendix. In addition to my duties here a good deal of time during the year has been spent on inspection duty at Phœnixville, Pa., Newark, N. J., Southwark Foundry, Philadelphia, Pa., Birdsboro, Pa., and Chester, Pa., and on duties connected with the U. S. Life-Saving Service.

Respectfully submitted.

D. A. LYLE,
Captain, Ord. Dept., U. S. Army, Inspector.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

(5129–'92.)

Midvale Steel Works.—Tensile tests for 12-inch B. L. rifled mortar (cast-iron body, steel hooped).

TABLE I.—TRUNNION HOOPS B_2.*

[Specimens 4 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section. Contract of December 1, 1890.]

Midvale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
17077	12 M R 58 T H—T_1 O	55,000	98,600	.00175	18.80	41.07	2 inches from end	Accepted.
17063	T_2 M	53,000	97,200	.00162	20.30	43.75	1⅞ inches from end	
17081	T_3 I	57,000	97,200	.00175	19.50	52.19	2 inches from end	
17091	12 M R 59 T H—T_1 O	52,000	100,000	.00162	17.40	37.75	1 inch from end	Accepted.
17080	T_2 M	50,000	96,000	.00155	19.00	40.25	1¾ inches from end	
17092	T_3 I	53,000	98,800	.00175	18.50	40.25	1½ inches from end	
17184	12 M R 60 T H—T_1 O	54,000	101,200	.00162	18.70	39.14	2 inches from end	Accepted.
17175	T_2 M	52,000	102,000	.00157	17.30	34.64	2⅛ inches from end	
17183	T_3 I	55,000	102,000	.00175	19.40	42.15	2 inches from end	
17439	12 M R 61 T H—T_1 O	53,000	100,400	.00167	17.00	34.64	1¾ inches from end	Accepted.
17420	T_2 M	51,000	100,800	.00162	13.40	20.77	1½ inches from end	
17440	T_3 I	52,000	102,920	.00160	15.90	29.96	1⅝ inches from end	
17712	12 M R 62 T H—T_1 O	59,000	101,600	.00192	18.70	47.15	2 inches from end	Accepted.
17687	T_2 M	53,000	97,200	.00172	18.60	40.25	2 inches from end	
17713	T_3 I	59,000	102,800	.00195	17.10	45.60	1¼ inches from end	
17722	12 M R 63 T H—T_1 O	57,000	98,000	.00165	18.30	50.70	1 inch from end	Accepted.
17692	T_2 M	51,000	97,400	.00155	18.00	33.48	1⅝ inches from end	
17721	T_3 I	57,000	99,600	.00177	19.90	48.18	1⅜ inches from end	
17801	12 M R 64 T H—T_1 O	52,000	98,000	.00162	20.00	41.07	1 inch from end	Accepted.
17780	T_2 M	50,000	94,400	.00162	21.40	51.20	1¾ inches from end	
17802	T_3 I	53,000	97,600	.00165	20.40	50.10	2 inches from end	
17787	12 M R 65 T H—T_1 O	57,000	97,600	.00170	17.40	30.85	1¼ inches from end	Accepted.
17774	T_2 M	50,000	94,000	.00162	19.75	38.86	1⅜ inches from end	
17788	T_3 I	53,000	96,000	.00170	19.30	46.89	1¾ inches from end	
17818	12 M R 66 T H—T_1 O	54,000	100,800	.00170	18.00	34.34	1⅛ inches from end	Accepted.
17786	T_2 M	56,000	102,000	.00180	17.90	37.47	1½ inches from end	
17816	T_3 I	57,000	104,000	.00175	18.30	38.03	2 inches from end	
17852	12 M R 67 T H—T_1 O	54,000	100,800	.00175	17.90	39.14	2 inches from end	Accepted.
17801	T_2 M	51,000	94,400	.00177	22.30	48.44	2⅛ inches from end	
17854	T_3 I	55,000	97,600	.00155	19.70	47.66	1⅝ inches from end	
17951	12 M R 68 T H—T_1 O	55,000	104,200	.00175	16.90	37.75	2 inches from end	Accepted.
17876	T_2 M	52,000	100,000	.00157	18.30	40.52	1 inch from end	
17954	T_3 I	58,000	104,400	.00182	18.10	41.61	2 inches from end	
17978	12 M R 69 T H—T_1 O	51,000	99,200	.00175	16.00	28.77	1 inch from end	Accepted.
17955	T_2 M	48,000	97,600	.00155	19.20	36.63	1⅞ inches from end	
17979	T_3 I	52,000	100,000	.00162	18.20	37.47	1½ inches from end	

18064	12 M R 70 T H—T_1 O	54,000	102,400	.00175	14.20	26.35	1 inch from end	Accepted.
18052	T_2 M	54,000	101,600	.00162	11.80	34.34	$1\frac{5}{8}$ inches from end	
18069	T_3 I	53,000	100,000	.00157	18.60	39.14	$2\frac{1}{4}$ inches from end	
18077	12 M R 71 T H—T_1 O	60,000	107,200	.00200	15.00	34.92	$1\frac{3}{8}$ inches from end	Accepted.
18065	T_2 M	58,000	108,800	.00187	15.10	31.14	1 inch from end	
18078	T_3 I	61,000	107,600	.00200	16.10	38.30	$1\frac{3}{4}$ inches from end	
18079	12 M R 72 T H—T_1 O	54,000	106,400	.00180	14.00	28.47	$1\frac{1}{4}$ inches from end	Accepted.
18071	T_2 M	53,000	104,000	.00157	15.40	29.07	2 inches from end	
18086	T_3 I	59,000	108,000	.00190	16.70	33.48	$1\frac{3}{4}$ inches from end	
18087	12 M R 73 T H—T_1 O	55,000	105,600	.00172	15.10	27.56	$1\frac{3}{4}$ inches from end	Accepted.
18072	T_2 M	53,000	103,200	.00162	16.30	27.87	$1\frac{1}{2}$ inches from end	
18088	T_3 I	57,000	106,400	.00180	16.50	38.30	$1\frac{1}{2}$ inches from end	
18205	12 M R 74 T H—T_1 O	53,000	102,400	.00175	18.20	35.49	$1\frac{1}{2}$ inches from end	Accepted.
18187	T_2 M	54,000	98,800	.00155	19.50	43.22	2 inches from end	
18206	T_3 I	58,000	101,800	.00175	20.00	45.34	1 inch from end	
18227	12 M R 75 T H—T_1 O	53,000	104,800	.00167	15.30	30.55	1 inch from end	Accepted.
18215	T_2 M	53,000	103,200	.00167	17.30	29.07	$1\frac{3}{4}$ inches from end	
18228	T_3 I	56,000	105,600	.00182	16.20	34.34	$1\frac{3}{4}$ inches from end	
18470	12 M R 76 T H—T_1 O	54,000	102,000	.00175	18.00	34.05	$1\frac{1}{2}$ inches from end	Accepted.
18454	T_2 M	56,000	103,200	.00200	16.00	29.07	$1\frac{3}{4}$ inches from end	
18471	T_3 I	56,000	107,200	.00182	15.30	30.55	$1\frac{3}{8}$ inches from end	
18571	12 M R 77 T H—T_1 O	54,000	100,400	.00170	17.30	34.64	$1\frac{3}{4}$ inches from end	Accepted.
18555	T_2 M	53,000	100,800	.00180	15.00	28.17	$1\frac{3}{8}$ inches from end	
18572	T_3 I	55,000	98,800	.00185	17.80	40.79	$1\frac{1}{2}$ inches from end	
18570	12 M R 78 T H—T_1 O	51,000	94,400	.00150	22.20	47.92	2 inches from end	Accepted.
18554	T_2 M	50,000	96,800	.00167	18.00	32.90	1 inch from end	
18573	T_3 I	54,000	97,200	.00182	14.35	18.87	$1\frac{3}{4}$ inches from end	

TABLE II.—HOOPS A_2 AND A_4.†

[Specimens 4 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section.]

	Hoops A_2.							
18242	12 M R 70 A_2—T_1 O	62,000	106,800	.00202	15.40	34.34	$1\frac{3}{4}$ inches from end	Accepts 70 A_2.
18179	T_2 M	56,000	102,800	.00175	16.70	33.48	$1\frac{1}{2}$ inches from end	
18252	T_3 I	55,000	101,600	.00172	17.70	32.32	$1\frac{1}{4}$ inches from end	
18278	12 M R 71 A_2—T_1 O	56,000	104,400	.00157	15.50	25.43	2 inches from end	Accepts 71 A_2.
18189	T_2 M	56,000	102,000	.00182	13.60	24.82	$1\frac{3}{4}$ inches from end	
18276	T_3 I	59,000	105,600	.00175	17.00	36.34	$1\frac{3}{4}$ inches from end	
	Hoops A_4.							
17804	12 M R 65 A_4—T_1 O	57,000	97,600	.00180	9.15	12.69	$\frac{3}{4}$ inch from end, broke through blow-hole.	Accepts 65 A_4.
17742	T_2 M	54,000	100,000	.00182	18.20	39.14	$1\frac{3}{4}$ inches from end, broke through blow-hole.	
17815	T_3 I	59,000	102,000	.00177	18.00	41.34	$1\frac{5}{8}$ inches from end	

*Continued from page 330, Report of Chief of Ordnance, 1891.

†Continued from page 335, Report of Chief of Ordnance, 1891.

Midvale Steel Works.—Tensile tests for 12-inch B. L. rifled mortar (cast-iron body, steel hooped)—Continued.

TABLE II.—HOOPS A_2 AND A_4—Continued.

[Specimens 4 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section.]

Mid-vale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
	Hoops A_4—Continued.							
17574		*Pounds.*	*Pounds.*					
17531	12 M R 68 A_4—T_1 O	58,000	98,800	.00177	20.30	44.81	1¾ inches from end	Accepts 68 A_4.
17564	T_2 M	54,000	98,800	.00157	18.20	39.14	1 inch from end	
17853	T_3 I	59,000	99,600	.00177	18.30	45.86	2 inches from end	
17792	12 M R 69 A_4—T_1 O	58,000	109,200	.00172	13.50	26.35	1¾ inches from end	Accepts 69 A_4, also 63 A_2.
17855	T_2 M	59,000	108,120	.00180	13.70	26.96	2⅛ inches from end	
17976	T_3 I	56,000	100,800	.00175	14.90	38.03	1 inch from end	
17883	12 M R 70 A_4—T_1 O	56,000	96,000	.00180	20.90	50.96	1¾ inches from end	Accepts 70 A_4, also 66 B_6.
17977	T_2 M	53,000	90,400	.00157	23.70	52.65	1¾ inches from end	
17952	T_3 I	56,000	96,800	.00175	17.50	47.66	1¾ inches from end	
17877	12 M R 71 A_4—T_1 O	60,000	110,400	.00190	14.40	24.82	1 inch from end	Accepts 71 A_4, also 65 A_2.
17953	T_2 M	57,000	106,000	.00180	13.70	27.26	1¼ inches from end	
18020	T_3 I	57,000	104,400	.00185	16.20	34.34	1¾ inches from end	
17961	12 M R 72 A_4—T_1 O	55,000	106,600	.00177	16.20	30.52	1¾ inches from end	Accepts 72 A_4, also 68 A_1.
18021	T_2 M	58,000	107,200	.00197	15.50	28.77	2 inches from end	
18037	T_3 I	63,000	112,000	.00205	14.50	28.47	1 inch from end	
17974	12 M R 73 A_4—T_1 O	57,000	104,800	.00185	16.30	35.49	1½ inches from end	Accepts 73 A_4, also 67 B_6.
18038	T_2 M	59,000	104,800	.00185	16.50	37.19	1¾ inches from end	
18255	T_3 I	56,000	98,800	.00185	16.20	44.28	1½ inches from end	
18164	12 M R 74 A_4—T_1 O	56,000	97,600	.00180	17.90	44.02	1⅛ inches from end	Accepts 74 A_4, also 72 B_6.
18256	T_2 M	55,000	103,200	.00180	17.60	36.06	1 inch from end	
	T_3 I	58,000	102,000	.00190	18.20	42.69	1¼ inches from end	

TABLE III.—HOOPS A_3.*

17658	12 M R 65 A_3—T_1 O	57,000	104,800	.00185	14.40	30.55	1½ inches from end	Accepts 65 A_3.
17628	T_2 M	53,000	100,000	.00172	15.70	33.48	2 inches from end	
17659	T_3 I	52,000	96,000	.00180	17.30	45.34	1 inch from end	
17907	12 M R 66 A_3—T_1 O	57,000	96,400	.00165	18.20	48.44	2 inches from end	Accepts 66 A_3, also 66 A_1.
17854	T_2 M	56,000	96,400	.00175	18.00	44.54	1 inch from end	
17906	T_3 I	55,000	94,000	.00165	17.40	47.15	1¼ inches from end	

17853	12 M R 67 A_3—T_1 O	58,000	100,000	.00185	16.50	40.25	1 inch from end	Accepts 67 A_3, also 69 A_1.
18017	T_2 M	55,000	96,800	.00170	19.70	41.34	2 inches from end	
18058	T_3 I	59,000	99,600	.00180	18.00	46.38	1 inch from end	
18145	12 M R 68 A_3—T_1 O	60,000	100,400	.00195	18.40	43.22	$1\frac{3}{8}$ inches from end	Accepts 68 A_3, also 70 B_6.
18080	T_2 M	54,000	99,600	.00175	17.20	39.14	$\frac{3}{4}$ inch from end	
18146	T_3 I	57,000	97,600	.00180	19.30	44.02	$1\frac{3}{4}$ inches from end	
18098	12 M R 69 A_3—T_1 O	61,000	101,200	.00192	19.40	43.75	$1\frac{3}{8}$ inches from end	Accepts 69 A_3, also 69 B_6.
18074	T_2 M	55,000	99,200	.00162	18.30	42.42	2 inches from end	
18103	T_3 I	60,000	102,400	.00200	17.70	46.12	$1\frac{1}{2}$ inches from end	
18128	12 M R 70 A_3—T_1 O	56,000	101,600	.00185	19.70	41.61	$1\frac{5}{8}$ inches from end	Accepts 70 A_3, also 70 A_1.
18081	T_2 M	54,000	98,000	.00180	20.30	44.54	$1\frac{1}{2}$ inches from end	
18129	T_3 I	57,000	101,200	.00182	17.40	45.34	2 inches from end	
18099	12 M R 71 A_3—T_1 O	55,000	98,000	.00155	17.30	43.75	$1\frac{1}{4}$ inches from end	Accepts 71 A_3, also 68 B_6.
18073	T_2 M	53,000	97,000	.00170	17.90	38.03	2 inches from end	
18097	T_3 I	54,000	96,000	.00177	19.10	48.44	$1\frac{3}{4}$ inches from end	
18257	12 M R 72 A_3—T_1 O	58,000	102,800	.00182	17.50	39.14	$1\frac{5}{8}$ inches from end	Accepts 72 A_3, also 73 B_6.
18132	T_2 M	57,000	103,800	.00172	15.00	35.49	$1\frac{3}{4}$ inches from end	
18258	T_3 I	57,000	102,600	.00167	16.20	40.79	$2\frac{1}{8}$ inches from end	
18216	12 M R 73 A_3—T_1 O	60,000	106,000	.00200	15.30	31.43	$1\frac{5}{8}$ inches from end	Accepts 73 A_3, also 71 A_1.
18198	T_2 M	58,000	104,800	.00180	16.20	30.85	$2\frac{1}{8}$ inches from end	
18217	T_3 I	60,000	105,600	.00197	13.70	34.34	$\frac{3}{4}$ inch from end	

TABLE IV.—HOOPS A_5.†

17252	12 M R 51 A_5—T_1 O	59,000	100,000	.00182	16.70	44.28	$1\frac{3}{4}$ inches from end	Accepts 51 A_5.
17235	T_4 M	55,000	98,400	.00182	18.70	37.75	$1\frac{3}{4}$ inches from end	
17253	T_5 I	63,000	100,800	.00185	16.70	49.20	$1\frac{3}{4}$ inches from end	
17270	12 M R 53 A_5—T_1 O	63,000	112,000	.00197	14.80	28.17	$1\frac{5}{8}$ inches from end	Accepts 53 A_5.
17250	T_3 M	54,000	100,800	.00175	15.90	31.43		
17262	T_4 I	55,000	102,400	.00175	17.00	36.63	$1\frac{5}{8}$ inches from end	
17345	12 M R 60 A_5—T_1 O	56,000	100,400	.00180	17.70	39.96	2 inches from end	Accepts 60 A_5.
17323	T_2 M	55,000	100,000	.00177	15.70	31.73	$1\frac{1}{4}$ inches from end	
17346	T_3 I	52,000	95,600	.00172	15.90	40.79	1 inch from end	
17348	12 M R 61 A_5—T_1 O	57,000	101,200	.00177	17.70	26.96	1 inch from end	Accepts 61 A_5.
17324	T_2 M	53,000	98,640	.00175	16.50	26.05	$1\frac{5}{8}$ inches from end	
17347	T_3 I	56,000	100,800	.00175	16.60	30.55	$1\frac{5}{8}$ inches from end	
17553	12 M R 64 A_5—T_1 O	56,000	99,600	.00167	19.00	41.88	$1\frac{3}{4}$ inches from end	Accepts 64 A_5.
17498	T_3 M	52,000	94,000	.00165	19.75	44.02	$1\frac{3}{4}$ inches from end	
17552	T_4 I	57,000	96,800	.00180	20.80	52.65	$1\frac{3}{4}$ inches from end	
17463	12 M R 65 A_5—T_1 O	54,000	96,800	.00170	17.20	38.58	$1\frac{5}{8}$ inches from end	Accepts 65 A_5.
17442	T_2 M	53,000	96,400	.00165	16.10	32.61	$1\frac{5}{8}$ inches from end	
17464	T_3 I	52,000	95,600	.00160	16.70	37.19	1 inch from end	
17499	12 M R 69 A_5—T_1 O	57,000	101,600	.00177	16.20	25.43	$1\frac{1}{2}$ inches from end	Accepts 69 A_5.
17485	T_2 M	54,000	100,000	.00172	17.20	28.47	2 inches from end	
17511	T_3 I	57,000	101,200	.00175	16.10	33.76	1 inch from end	

*Continued from page 332, Report of Chief of Ordnance, 1891.

†Continued from page 336, Report of Chief of Ordnance, 1891.

Midvale Steel Works.—Tensile tests for 12-inch B. L. rifled mortar (cast-iron body, steel hooped)—Continued.

TABLE IV.—HOOPS A_5—Continued.

[Specimens 4 inches long between shoulders, diameter, 0.564 and 0.25 square inch cross section.]

Midvale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
17612	12 M R 66 A_5—T_3 O	52,000	92,800	.00155	22.60	51.94	1¾ inches from end	Accepts 66 A_5.
17627	T_4 M	52,000	94,000	.00150	19.30	47.40	1⅝ inches from end	
17595	T_5 I	50,000	95,320	.00155	17.80	44.81	¾ inch from end	
17740	12 M R 67 A_5—T_1 O	57,000	104,400	.00180	17.10	36.34	1¾ inches from end	Accepts 67 A_5.
17711	T_4 M	50,000	94,600	.00169	18.40	43.49	1⅝ inches from end	
17741	T_5 I	52,000	95,680	.00175	20.00	43.49	1 inch from end	
17606	12 M R 68 A_5—T_1 O	55,000	98,800	.00172	17.90	39.96	1¼ inches from end	Accepts 68 A_5.
17582	T_3 M	52,000	96,800	.00172	19.20	41.07	1⅝ inches from end	
17616	T_4 I	54,000	97,400	.00165	18.25	41.61	1⅝ inches from end	
17583	12 M R 70 A_5—T_1 O	58,000	103,600	.00180	17.40	38.03	1⅝ inches from end	Accepts 70 A_5.
17565	T_2 M	53,000	101,600	.00165	13.50	24.82	¾ inch from end	
17584	T_3 I	53,000	100,800	.00167	16.30	39.96	1⅝ inches from end	
17645	12 M R 71 A_5—T_1 O	55,000	103,200	.00185	16.60	34.92	1¼ inches from end	Accepts 71 A_5.
17615	T_2 M	57,000	104,400	.00187	15.50	28.47	1⅛ inches from end	
17646	T_3 I	56,000	106,000	.00182	12.05	13.02	1⅝ inches from end	
17781	12 M R 72 A_5—T_1 O	61,000	104,800	.00205	18.10	40.52	1¾ inches from end	Accepts 72 A_5.
17729	T_3 M	59,000	107,600	.00192	16.70	34.05	2 inches from end	
17782	T_4 I	58,000	103,000	.00182	16.15	8.00	½ in. from end; broke through slag spot	
17800	T_5 I	61,000	107,200	.00190	17.50	39.41	1¾ inches from end	
17686	12 M R 73 A_5—T_1 O	59,000	98,800	.00192	18.20	45.34	2 inches from end	Accepts 73 A_5.
17657	T_2 M	56,000	100,080	.00172	14.90	30.85	1½ inches from end	
17685	T_3 I	57,000	98,800	.00160	18.40	38.86	2⅛ inches from end	
17666	12 M R 75 A_5—T_1 O	60,000	102,400	.00200	17.20	40.52	1½ inches from end	Accepts 75 A_5.
17656	T_2 M	58,000	102,400	.00185	14.70	29.07	1½ inches from end	
17667	T_3 I	62,000	109,600	.00202	14.00	27.56	1½ inches from end	
17668	12 M R 76 A_5—T_1 O	62,000	102,000	.00210	14.60	26.96	1⅝ inches from end	Accepts 76 A_5.
17655	T_2 M	55,000	104,000	.00185	13.40	24.20	1⅛ inches from end	
17669	T_3 I	61,000	104,600	.00185	16.00	31.14	1¾ inches from end	
17984	12 M R 77 A_5—T_1 O	57,000	98,000	.00180	21.20	46.38	1¾ inches from end	Accepts 77 A_5.
17949	T_2 M	54,000	97,600	.00175	19.20	37.19	1 inch from end	
17975	T_3 I	56,000	96,400	.00175	17.20	33.48	1½ inches from end	
18018	12 M R 78 A_5—T_1 O	55,000	95,600	.00175	20.00	43.49	1 inch from end	Accepts 78 A_5.
17994	T_2 M	55,000	100,400	.00167	19.20	38.86	1¾ inches from end	
18019	T_3 I	56,000	100,000	.00182	18.20	37.75	1½ inches from end	
18035	12 M R 79 A_5—T_1 O	55,000	96,000	.00175	20.30	45.86	2 inches from end	Accepts 79 A_5.
17995	T_2 M	53,000	95,200	.00167	18.00	31.14	1½ inches from end	
18036	T_3 I	53,000	95,800	.00177	20.00	39.41	1⅝ inches from end	

18047	12 M R 80 A_5—T_1 O	55,000	95,000	.00177	20.80	44.54	$1\frac{1}{2}$ inches from end	Accepts 80 A_5.
17996	T_2 M	52,000	95,000	.00167	17.80	35.49	$1\frac{3}{4}$ inches from end	
18049	T_3 I	51,000	92,800	.00167	19.80	50.70	$1\frac{3}{4}$ inches from end	
18060	12 M R 81 A_5—T_1 O	55,000	98,800	.00157	13.60	25.13	1 inch from end	Accepts 81 A_5.
18027	T_2 M	50,000	93,600	.00150 to .00175	16.00	24.82	$1\frac{3}{4}$ inches from end	
18063	T_3 I	50,000	92,200	.00160	21.20	45.07	2 inches from end	
18057	12 M R 82 A_5—T_1 O	55,000	100,400	.00162	19.30	40.79	$2\frac{1}{2}$ inches from end	Accepts 82 A_5.
18024	T_2 M	53,000	100,400	.00170	19.60	40.25	$1\frac{5}{8}$ inches from end	
18055	T_3 I	54,000	100,400	.00165	19.00	43.22	$1\frac{5}{8}$ inches from end	
18238	12 M R 83 A_5—T_1 O	57,000	105,600	.00180	19.00	31.43	2 inches from end	Accepts 83 A_5.
18201	T_3 M	53,000	96,000	.00180	19.30	41.61	$1\frac{3}{4}$ inches from end	
18239	T_4 I	54,000	96,000	.00175	18.00	42.95	$1\frac{3}{4}$ inches from end	
18158	12 M R 84 A_5—T_1 O	54,000	97,200	.00177	14.50	24.51	2 inches from end	Accepts 84 A_5.
18101	T_2 M	53,000	94,000	.00185	16.30	41.34	$1\frac{5}{8}$ inches from end	
18159	T_3 I	52,000	93,200	.00172	18.70	39.14	$1\frac{1}{2}$ inches from end	
18157	12 M R 85 A_5—T_1 O	57,000	102,400	.00187	16.90	32.02	$2\frac{1}{8}$ inches from end	Accepts 85 A_5.
18126	T_2 M	56,000	102,800	.00182	14.80	26.05	$1\frac{7}{8}$ inches from end	
18149	T_3 I	59,000	102,800	.00185	16.80	30.25	2 inches from end	
18200	12 M R 86 A_5—T_1 O	53,000	98,000	.00160	18.20	41.07	$2\frac{1}{8}$ inches from end	Accepts 86 A_5.
18162	T_2 M	52,000	96,400	.00165	19.60	38.30	$2\frac{1}{4}$ inches from end	
18199	T_3 I	50,000	91,600	.00150 to .00200	20.80	44.81	$1\frac{3}{4}$ inches from end	
18225	12 M R 87 A_5—T_1 O	52,000	95,600	.00167	16.10	41.34	1 inch from end	Accepts 87 A_5.
18163	T_2 M	53,000	94,800	.00170	18.30	34.64	1 inch from end	
18237	T_3 I	53,000	94,000	.00172	20.70	35.78	$1\frac{1}{2}$ inches from end	
18651	12 M R 88 A_5—T_5 O	55,000	99,200	.00157	17.60	29.07	1 inch from end	Accepts 88 A_5.
18673	T_6 M	57,000	100,400	.00192	17.50	35.78	$1\frac{1}{2}$ inches from end	
18674	T_7 I	58,000	101,200	.00187	17.50	47.92	$1\frac{3}{4}$ inches from end	
18517	12 M R 89 A_5—T_1 O	59,000	104,400	.00182	15.60	32.32	2 inches from end	Accepts 89 A_5.
18478	T_2 M	53,000	96,800	.00175	15.00	26.66	$1\frac{3}{4}$ inches from end	
18518	T_3 I	53,000	97,200	.00167	18.00	34.34	2 inches from end	

TABLE V.—HOOPS B_1, B_4, AND B_5.*

	Hoops B_1.							
17301	12 M R 68 B_1—T_1 O	54,000	104,800	.00180	14.00	26.96	$1\frac{3}{4}$ inches from end	Accepts 68 B_1, also 68 B_4.
17290	T_2 M	54,000	105,200	.00155	14.10	26.05	$1\frac{7}{8}$ inches from end	
17302	T_3 I	55,000	104,000	.00177	13.50	32.61	$1\frac{1}{2}$ inches from end	
17335	12 M R 69 B_1—T_1 O	57,000	106,800	.00175	13.80	29.96	$1\frac{5}{8}$ inches from end	Accepts 69 B_1 and 65 B_4.
17312	T_2 M	58,000	106,400	.00170	14.50	27.56	$1\frac{3}{4}$ inches from end	
17334	T_3 I	60,000	110,800	.00180	14.50	26.96	$1\frac{7}{8}$ inches from end	
18003	12 M R 70 B_1—T_1 O	62,000	109,600	.00200	14.00	26.05	$1\frac{3}{4}$ inches from end	Accepts 70 B_1 and 67 A_2.
17908	T_2 M	64,000	110,400	.00205	14.00	28.77	2 inches from end	
18002	T_3 I	62,000	110,000	.00195	13.80	31.43	$\frac{5}{8}$ inch from end	
18022	12 M R 71 B_1—T_1 O	61,000	110,000	.00190	16.10	30.55	$1\frac{1}{8}$ inches from end	Accepts 71 B_1 and 68 A_2.
17950	T_2 M	56,000	101,200	.00180	15.90	38.30	$1\frac{3}{4}$ inches from end	
18023	T_3 I	57,000	100,000	.00180	16.30	45.05	1 inch from end	

*Continued from page 338, Report of Chief of Ordnance, 1891.

Midvale Steel Works.—Tensile tests for 12-inch B. L. rifled mortar (cast-iron body, steel hooped)—Continued.

TABLE V.—HOOPS B_1, B_4, AND B_5—Continued.

[Specimens 4 inches long between shoulders, diameter , and 0.25 square inch cross section.]

Midvale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
	Hoops B_1—Continued.	*Pounds.*	*Pounds.*					
18229	12 M R 72 B_1—T_1 O	54,000	106,400	.00175	14.50	27.26	2 inches from end	Accepts 72 B_1 and 72 B_4.
18202	T_2 M	54,000	104,800	.00175	15.70	26.96	1¾ inches from end	
18230	T_3 I	57,000	105,600	.00177	13.70	27.87	1½ inches from end	
18325	12 M R 73 B_1—T_1 O	54,000	102,400	.00180	16.90	33.48	1½ inches from end	Accepts 73 B_1 and 73 B_4.
18253	T_2 M	53,000	104,000	.00175	16.30	29.37	1 inch from end	
18327	T_3 I	58,000	106,400	.00187	16.20	32.32	1¾ inches from end	
	*Hoops B_4.**							
18240	12 M R 66 B_4—T_1 O	62,000	107,600	.00200	16.20	36.08	1¼ inches from end	Accepts 66 B_4 and 71 B_5.
18188	T_3 M	59,000	104,000	.00175	14.30	38.30	1¾ inches from end	
18241	T_4 I	61,000	102,400	.00200	17.50	44.28	2⅛ inches from end	
18224	12 M R 67 B_4—T_1 O	58,000	102,800	.00180	14.20	26.05	2 inches from end	Accepts 67 B_4 and 71 B_5.
18180	T_3 M	55,000	102,400	.00182	12.10	15.97	⅞ inch from end	
18226	T_4 I	54,000	98,800	.00157	12.00	15.00	1⅝ inches from end	
18102	12 M R 68 B_4—T_1 O	61,000	104,000	.00202	16.40	39.14	1 inch from end	Accepts 68 B_4.
18082	T_2 M	61,000	104,800	.00200	13.90	24.51	1⅜ inches from end	
18127	T_3 I	62,000	103,200	.00200	17.60	40.52	1¾ inches from end	
	Hoops B_5.†							
17278	12 M R 55 B_5—T_1 O	56,000	107,600	.00177	14.70	26.05	1¾ inches from end	Accepts 55 B_5 and 60 A_1.
17228	T_2 M	53,000	104,400	.00177	13.50	28.77	1⅝ inches from end	
17287	T_3 I	57,000	105,600	.00180	14.80	30.55	2 inches from end	
17425	12 M R 56 B_5—T_1 O	61,000	106,800	.00195	16.60	38.03	1⅜ inches from end	Accepts 56 B_5 and 57 A_2.
17383	T_3 M	63,000	107,600	.00205	15.00	40.79	1¼ inches from end	
17426	T_4 I	64,000	106,400	.00205	13.10	40.79	1 inch from end	
17482	12 M R 57 B_5—T_1 O	61,000	101,600	.00190	19.00	44.54	2 inches from end	Accepts 57 B_5 and 63 A_1.
17456	T_3 M	56,000	101,200	.00177	16.10	41.88	1¾ inches from end	
17483	T_4 I	57,000	99,600	.00175	17.20	45.34	1½ inches from end	
17882	12 M R 58 B_5—T_1 O	56,000	102,000	.00180	18.10	34.05	1½ inches from end	Accepts 58 B_5 and 64 A_2.
17793	T_3 M	56,000	105,600	.00155	15.30	26.96	2 inches from end	
17857	T_4 I	56,000	106,800	.00160	15.50	32.32	1¼ inches from end	
17368	12 M R 59 B_5—T_1 O	58,000	106,800	.00187	13.20	22.96		Accepts 59 B_5 and 60 A_2.
17336	T_2 M	55,000	107,600	.00172	13.60	23.58	1⅛ inches from end	
17369	T_3 I	60,000	108,400	.00195	15.20	29.37	1⅝ inches from end	

TABLE VI.—HOOPS B_3.

[Specimens 2 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section.]

17231	12 M R 61 B_3—T_1 O	57,000	101,600	.00180	17.80	41.07	$2\frac{1}{4}$ inches from end	Accepts 61 B_3 and 67 B_3.
17206	T_2 M	55,000	100,000	.00175	18.20	15.97	$1\frac{3}{8}$ inches from end	
17232	T_3 I	55,000	96,000	.00180	19.10	48.44	2 inches from end	
17226	12 M R 62 B_3—T_1 O	55,000	95,600	.00172	20.60	46.12	$1\frac{1}{2}$ inches from end	Accepts 62 B_3 and 66 B_3.
17205	T_2 M	56,000	97,600	.00162	18.70	43.75	2 inches from end	
17229	T_3 I	56,000	95,600	.00170	18.70	53.16	$1\frac{3}{4}$ inches from end	
17230	12 M R 63 B_3—T_1 O	57,000	101,600	.00170	19.40	49.71	$1\frac{3}{4}$ inches from end	Accepts 63 B_3 and 68 B_3.
17207	T_2 M	56,000	99,200	.00175	17.20	41.07	$1\frac{3}{4}$ inches from end	
17233	T_3 I	55,000	94,000	.00170	19.50	54.36	$2\frac{1}{4}$ inches from end	
17279	12 M R 64 B_3—T_1 O	57,000	102,000	.00190	18.30	40.52	$1\frac{5}{8}$ inches from end	Accepts 64 B_3 and 69 B_3.
17227	T_2 M	55,000	98,000	.00180	16.70	38.30	$1\frac{1}{4}$ inches from end	
17280	T_3 I	56,000	96,400	.00180	19.40	53.88	$1\frac{3}{4}$ inches from end	
17288	12 M R 65 B_3—T_1 O	60,000	104,400	.00185	18.10	41.34	2 inches from end	Accepts 65 B_3 and 70 B_3.
17246	T_2 M	54,000	99,200	.00162	16.30	31.73	2 inches from end	
17281	T_3 I	54,000	95,200	.00177	18.50	49.20		
18203	12 M R 71 B_3—T_1 O	55,000	102,000	.00175	17.30	39.69	$1\frac{3}{4}$ inches from end	Accepts 71 B_3 and 74 B_3.
18160	T_3 M	58,000	100,800	.00187	14.10	27.56	$1\frac{3}{4}$ inches from end	
18204	T_4 I	59,000	102,000	.00197	17.00	42.95	$1\frac{3}{4}$ inches from end	
18056	12 M R 72 B_3—T_1 O	59,000	106,000	.00190	16.40	32.61	$2\frac{1}{3}$ inches from end	Accepts 72 B_3 and 69 B_4.
18016	T_2 M	57,000	105,600	.00180	15.60	29.37	2 inches from end	
18059	T_3 I	63,000	111,600	.00200	13.00	27.26	$1\frac{1}{4}$ inches from end	
18169	12 M R 73 B_3—T_1 O	58,000	108,400	.00187	14.00	22.65	$1\frac{1}{8}$ inches from end	Accepts 73 B_3 and 70 B_4.
18147	T_2 M	58,000	109,200	.00175	13.00	20.45	$1\frac{1}{4}$ inches from end	
18167	T_3 I	58,000	103,600	.00192	15.50	35.49	$1\frac{7}{8}$ inches from end	

TABLE VII.—HOOPS B_5.‡

[Specimens 4 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section.]

17427	12 M R 60 B_5—T_1 O	61,000	107,600	.00197	17.50	38.03	$2\frac{1}{8}$ inches from end	Accepts 60 B_5 and 60 A_2
17386	T_3 M	60,000	106,800	.00202	16.30	34.05	$1\frac{5}{8}$ inches from end	
17428	T_4 I	64,000	108,000	.00202	16.20	38.03	2 inches from end	
17873	12 M R 61 B_5—T_1 O	56,000	99,200	.00172	16.65	40.25	1 inch from end	Accepts 61 B_5 and 61 A_1.
17833	T_3 M	58,000	102,800	.00172	16.70	43.75	$1\frac{1}{8}$ inches from end	
17874	T_4 I	56,000	97,000	.00177	19.50	51.20	$1\frac{3}{8}$ inches from end	
17997	12 M R 63 B_5—T_1 O	55,000	99,200	.00185	17.50	35.49		Accepts 63 B_5 and 67 A_1.
17947	T_2 M	54,000	99,600	.00167	17.80	36.65	2 inches from end	
17998	T_3 I	54,000	93,240	.00167	21.40	56.26	$1\frac{1}{2}$ inches from end	

* Continued from page 341, Report of Chief of Ordnance, 1891.
† Continued from page 342, Report of Chief of Ordnance, 1891. For remainder of Hoops B_5, see Table VII.
‡ Continued from page 342, Report of Chief of Ordnance, 1891,

Midvale Steel Works.—Tensile tests for 12-inch B. L. rifled mortar (cast-iron body, steel hooped)—Continued.

TABLE VII.—HOOPS B_5*—Continued.

[Specimens 4 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section.]

Mid-vale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
17999	12 M R 64 B_5—T_1 O	59,000	109,600	.00192	14.40	26.35	1¾ inches from end	Accepts 64 B_5 and 62 A_2.
17948	T_2 M	58,000	106,400	.00180	14.50	29.37	1¾ inches from end	
18000	T_3 I	53,000	98,000	.00167	17.00	39.41	1¼ inches from end	
18050	12 M R 65 B_5—T_1 O	56,000	100,000	.00177	15.00	38.58	¾ inch from end	Accepts 65 B_5.
18025	T_2 M	54,000	96,000	.00170	19.50	42.15	1½ inches from end	
18048	T_3 I	58,000	103,200	.00180	16.00	36.34	1¾ inches from end	
17604	12 M R 66 B_5—T_1 O	56,000	104,000	.00187	17.10	33.48	1⅝ inches from end	Accepts 66 B_5 and 64 A_1.
17573	T_2 M	54,000	101,200	.00157	15.90	33.48	1⅝ inches from end	
17605	T_3 I	51,000	96,000	.00160	17.75	42.69	2 inches from end	
17817	12 M R 67 B_5—T_1 O	55,000	98,000	.00175	18.50	40.25	1¾ inches from end	Accepts 67 B_5 and 62 B_5.
17748	T_2 M	53,000	97,400	.00162	17.60	40.79	1 inch from end	
17803	T_3 I	54,000	96,000	.00182	18.85	43.75	1½ inches from end	
18067	12 M R 68 B_5—T_1 O	57,000	99,600	.00180	19.70	45.86	2 inches from end	Accepts 68 B_5 and 69 A_2.
18051	T_2 M	53,000	96,800	.00167	19.70	40.79	1 inch from end	
18068	T_3 I	57,000	100,000	.00182	17.00	44.02	⅞ inch from end	
18291	12 M R 69 B_5—T_1 O	63,000	110,400	.00185	16.10	34.64	1⅝ inches from end	Accepts 69 B_5 and 74 A_1.
18256	T_3 M	62,000	107,600	.00200	15.90	37.72	1¾ inches from end	
18292	T_4 I	62,000	105,600	.00205	14.50	41.61	1⅛ inches from end	
18165	12 M R 70 B_5—T_1 O	58,000	107,200	.00187	16.80	30.25	1¼ inches from end	Accepts 70 B_5 and 72 A_2.
18131	T_2 M	56,000	106,400	.00165	15.60	29.07	1¼ inches from end	
18161	T_3 I	58,000	107,600	.00167	15.80	29.66	1⅝ inches from end	
18166	12 M R 71 B_5—T_1 O	54,000	96,400	.00177	19.20	47.15	1½ inches from end	Accepts 71 B_5.
18148	T_2 M	54,000	100,400	.00175	17.20	36.63	2 inches from end	
18169	T_3 I	57,000	101,600	.00185	21.00	42.15	1⅜ inches from end	
18324	12 M R 72 B_5—T_1 O	53,000	101,200	.00175	16.50	32.02	2 inches from end	Accepts 72 B_5 and 75 A_1.
18254	T_2 M	52,000	101,600	.00160	16.20	31.43	1 inch from end	
18326	T_3 I	56,000	104,000	.00175	15.00	31.73	1⅛ inches from end	
18289	12 M R 73 B_5—T_1 O	56,000	105,200	.00182	15.00	38.30	1½ inches from end	Accepts 73 B_5 and 73 A_1.
18251	T_2 M	55,000	101,200	.00172	16.30	33.76	1⅜ inches from end	
18290	T_3 I	58,000	103,600	.00192	15.80	41.07	¾ inch from end	
18259	12 M R 74 B_5—T_1 O	58,000	106,400	.00187	17.30	35.78	1⅞ inches from end	Accepts 74 B_5 and 72 A_1.
18236	T_2 M	53,000	103,200	.00180	15.20	27.56	1⅝ inches from end	
18275	T_3 I	58,000	108,400	.00187	15.20	36.06	1⅝ inches from end	

* Continued from page 342, Report of Chief of Ordnance. 1891.

TABLE VIII.—BREECH MECHANISM.*

[Specimens 3 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section.]

	(a) Breechblocks.							
18053	12 M R 52 B B—T_3 O	52,000	91,600	.00125	17.73	28.17	$\frac{1}{2}$ inch from end	Accepts 52 and 70 B B.
18070	T_4 M	53,000	92,400	.00130	21.30	36.06	$1\frac{3}{8}$ inches from end	
17441	12 M R 60 B B—T_1 O	54,000	94,400	.00153	18.73	33.76	$1\frac{3}{8}$ inches from end	Accepts 60 and 62 B B.
17460	T_2 M	48,000	94,000	.00153	19.60	35.21	1 inch from end	
17468	12 M R 61 B B—T_1 O	61,000	98,000	.00177	23.13	52.91	$1\frac{5}{8}$ inches from end	Accepts 61 and 63 B B.
17497	T_2 M	56,000	94,800	.00170	19.50	50.70	$1\frac{5}{8}$ inches from end	
17791	12 M R 64 B B—T_1 O	52,000	90,600	.00170	21.70	49.96	$1\frac{1}{4}$ inches from end	Accepts 64 and 68 B B.
17851	T_2 M	48,000	91,200	.00147	20.90	40.52	1 inch from end	
17789	12 M R 65 B B—T_1 O	48,000	90,000	.00153	21.30	42.95	1 inch from end	Accepts 65 and 67 B B.
17832	T_2 M	50,000	91,600	.00143	19.20	33.19	$1\frac{3}{4}$ inches from end	
17878	12 M R 66 B B—T_1 O	50,000	91,600	.00170	21.80	46.12	$1\frac{5}{8}$ inches from end	Accepts 66 and 69 B B.
17927	T_2 M	49,000	92,000	.00153	20.60	36.63	$1\frac{1}{2}$ inches from end	
17871	12 M R 71 B B—T_1 O	53,000	94,000	.00170	17.00	28.77	1 inch from end	Accepts 71 and 72 B B.
17914	T_2 M	52,000	95,200	.00180	18.40	38.30	$\frac{5}{8}$ inch from end	
17879	12 M R 73 B B—T_1 O	55,000	96,000	.00177	20.70	45.34	$1\frac{1}{2}$ inches from end	Accepts 73 and desk for Builders' Iron Foundry, Providence, R. I.
17928	T_2 M	50,000	94,800	.00167	21.60	39.69	$1\frac{1}{4}$ inches from end	
	(b) Front gas checks.†							
17467	12 M R 59 F G C—T_1 O	82,000	141,200	.00270	12.00	28.77	$1\frac{5}{8}$ inches from end	Accepts 59, 62, 63, and 64 F G C.
17484	T_2 M	82,000	140,000	.00267	12.70	30.55	$1\frac{1}{2}$ inches from end	
17500	12 M R 60 F G C—T_1 O	81,000	135,200	.00263	14.13	33.76	1 inch from end	Accepts 60, 65, 66, and 67 F G C.
17533	T_2 M	82,000	136,000	.00267	14.10	32.02	1 inch from end	
17512	12 M R 61 F G C—T_1 O	87,000	142,800	.00280	14.00	35.78	$1\frac{3}{8}$ inches from end	Accepts 61, 68, 69, and 70 F G C.
17551	T_2 M	84,000	138,800	.00260	13.80	32.90	$\frac{3}{4}$ inch from end	
17614	12 M R 71 F G C—T_1 O	77,000	132,000	.00250	10.20	12.36	1 inch from end	Accepts 71, 72, and 73 F G C.
17746	T_2 M	72,000	127,800	.00240	14.30	35.78	$1\frac{1}{4}$ inches from end	
	(c) Rear gas checks.‡							
17496	12 M R 59 R G C—T_1 O	76,000	130,480	.00233	14.50	33.48	$\frac{3}{4}$ inch from end	Accepts 59, 60, 61, and 62 R G C.
17532	T_2 M	73,000	128,400	.00220	16.00	33.48	$1\frac{1}{4}$ inches from end	
17585	12 M R 63 R G C—T_1 O	76,000	128,400	.00217	15.83	37.75	$1\frac{1}{2}$ inches from end	Accepts 63, 66, 67, and 68 R G C.
17644	T_2 M	76,000	128,000	.00253	16.70	38.03	$1\frac{1}{2}$ inches from end	
17617	12 M R 64 R G C—T_1 O	74,000	127,600	.00230	15.73	39.69	1 inch from end	Accepts 64, 72, and 73 R G C.
17745	T_2 M	72,000	128,000	.00223	13.20	25.13	$\frac{3}{4}$ inch from end	
17612	12 M R 65 R G C—T_1 O	79,000	134,000	.00257	13.60	34.34	1 inch from end	Accepts 65, 69, 70, and 71 R G C.
17744	T_2 M	79,000	134,800	.00267	14.90	34.05	$1\frac{1}{4}$ inches from end	

* Continued from page 347, Report of Chief of Ordnance, 1891.

† Continued from page 346, Report of Chief of Ordnance, 1891.

Midvale Steel Works.—Tensile tests for 3.6-inch B. L. rifle.

TABLE IX.—TUBES.

[Specimens 2 inches long between shoulders, diameter 0.505 inch, and 0.20 square inch cross section. Contract of March 10, 1892.]

Midvale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
20620	3″.6 R 1 T—B T_1 O	52,000	93,500	.00155	23.30	42.48	1⅛ inches from end	Accepts 1.
*4685	B T_2 M	51,000	93,100	.00165	17.00	23.90	½ inch from end	
20621	M T_1 O	49,000	90,000	.00165	22.40	45.43	1 inch from end	
20650	M T_2 M	53,000	91,000	.00165	22.40	46.03	⅞ inch from end	
20618	3″.6 R 2 T—B T_1 O	53,000	91,500	.00160	22.00	38.19	¾ inch from end	Accepts 2.
20630	B T_2 M	52,000	92,000	.00165	26.00	40.34		
20617	M T_1 O	53,000	93,000	.00175	25.20	47.18	1 inch from end	
*4686	M T_2 M	50,000	89,850	.00170	20.50	37.10	$\frac{7}{10}$ inch from end	
*4687	3″.6 R 3 T—B T_1 O	50,000	89,200	.00155	24.50	43.30	1¼ inches from end	Accepts 3.
20633	B T_2 M	50,000	88,000	.00160	23.20	45.13	¾ inch from end	
20673	M T_1 O	53,000	90,000	.00155	27.00	47.18	1 inch from end	
20634	M T_2 M	46,000	86,000	.00135	23.00	40.34	½ inch from end	
20674	3″.6 R 4 T—B T_1 M	43,000	87,000	.00120	24.00	33.10	½ inch from end	Accepts 4.
20651	B T_2 M	44,000	88,000	.00130	21.20	45.13	½ inch from end	
20675	M T_1 M	50,000	89,500	.00150	26.00	48.62	⅞ inch from end	
20652	M T_2 M	47,000	89,000	.00130	30.00	51.12	1⅛ inches from end	
20677	3″.6 R 5 T—B T_1 M	44,000	84,000	.00125	28.80	44.58	1 inch from end	Accepts 5.
20695	B T_2 M	41,000	80,000	.00115	21.00	25.81		
20678	M T_1 M	49,000	87,780	.00150	22.50	32.80	⅝ inch from end	
20696	M T_2 M	46,000	84,000	.00150	24.50	47.52	⅝ inch from end	
20790	3″.6 R 6 T—B T_1 M	49,000	91,000	.00130	19.00	35.05	⅝ inch from end	Accepts 6.
20813	B T_2 M	52,000	93,500	.00155	22.00	39.44	¾ inch from end	
20789	M T_1 M	51,000	91,500	.00155	21.40	41.28	1⅛ inches from end	
20812	M T_2 M	51,000	90,500	.00160	22.50	47.77	¾ inch from end	
20864	3″.6 R 7 T—B T_1 M	50,000	93,500	.00160	24.40	36.00	1⅛ inches from end	Accepts 7.
20916	B T_2 M	51,000	94,500	.00160	21.00	37.24	½ inch from end	
20910	M T_1 M	51,000	91,500	.00145	24.40	42.48	1 inch from end	
20865	M T_2 M	51,000	92,000	.00150	23.50	45.43	1 inch from end	
21030	3″.6 R 8 T—B T_1 M	50,000	89,500	.00150	20.30	43.48	⅝ inch from end	Accepts 8.
20987	B T_3 M	48,000	90,000	.00135	25.00	47.17	¾ inch from end	
21031	M T_2 M	52,000	90,000	.00155	23.00	39.14	¾ inch from end	
20988	M T_3 M	49,000	90,500	.00150	22.10	42.78	⅞ inch from end	

20926	3″.6 R 9 T—B T_1 M	50,000	97,000	.00150	21.00	44.88	$\frac{6}{8}$ inch from end	Accepts 9.	
20904	B T_2 M	51,000	94,500	.00145	23.00	40.04	$\frac{3}{4}$ inch from end		
20896	M T_1 M	51,000	89,500	.00130	24.30	49.47	$1\frac{1}{8}$ inches from end		
20934	M T_2 M	49,000	90,250	.00125	22.00	46.63	$\frac{6}{8}$ inch from end		
20911	3″.6 R 10 T—B T_1 M	52,000	92,000	.00160	23.50	44.88	$1\frac{1}{8}$ inches from end	Accepts 10.	
20893	B T_2 M	52,000	92,000	.00160	21.20	38.19	$\frac{3}{4}$ inch from end		
20915	M T_1 M	55,000	94,000	.00155	20.50	35.70	1 inch from end		
20894	M T_2 M	55,000	94,500	.00170	24.30	42.48	$\frac{6}{8}$ inch from end		
20953	3″.6 R 11 T—B T_1 M	53,000	93,000	.00140	24.00	38.49	1 inch from end	Accepts 11.	
20990	B T_2 M	52,000	95,000	.00140	20.50	30.50	$\frac{3}{4}$ inch from end		
20989	M T_1 M	50,000	91,500	.00135	23.80	36.64	1 inch from end		
20954	M T_2 M	54,000	94,000	.00165	25.00	37.59	1 inch from end		
21043	3″.6 R 12 T—B T_1 M	46,000	84,000	.00130	26.20	48.32	1 inch from end	Accepts 12.	
20969	B T_2 M	47,000	84,000	.00145	27.00	45.13	1 inch from end		
20970	M T_1 M	49,000	84,500	.00150	27.40	49.47	$\frac{3}{4}$ inch from end		
21044	M T_2 M	46,000	83,000	.00140	24.20	37.24	1 inch from end		
20971	3″.6 R 13 T—B T_1 M	52,000	95,500	.00160	20.50	35.70	1 inch from end	Accepts 13. Tube 14 rejected.	
21018	B T_2 M	52,000	97,000	.00150	21.00	39.74	$\frac{1}{2}$ inch from end		
20975	M T_1 M	51,000	93,000	.00130	23.50	49.47	$1\frac{1}{8}$ inches from end		
*4712	M T_2 M	46,000	85,600	.00170	22.00	49.10	$\frac{3}{4}$ inch from end		
21041	3″.6 R 15 T—B T_1 M	50,000	90,000	.00135	22.30	42.78	$1\frac{1}{8}$ inches from end	Accepts 15.	
21101	B T_2 M	51,000	90,000	.00160	23.50	36.94	1 inch from end		
21102	M T_1 M	54,000	92,500	.00155	20.50	40.04	1 inch from end		
21042	M T_2 M	52,000	92,000	.00135	22.00	41.28	$\frac{1}{2}$ inch from end		
21079	3″.6 R 16 T—B T_1 M	50,000	90,000	.00155	20.50	31.15	1 inch from end	Accepts 16.	
21153	B T_2 M	45,000	86,500	.00115	23.30	38.49	$\frac{3}{4}$ inch from end		
21154	M T_1 M	47,000	84,500	.00145	26.60	46.63	1 inch from end		
21080	M T_2 M	46,000	82,000	.00145	24.40	39.74	1 inch from end		
21083	3″.6 R 17 T—B T_1 M	44,000	84,500	.00135	21.50	27.51	$\frac{1}{2}$ inch from end	Accepts 17.	
21141	B T_2 M	43,000	83,500	.00125	23.90	42.18	$\frac{1}{2}$ inch from end		
21128	M T_1 M	43,000	80,000	.00130	27.00	49.31	1 inch from end		
21084	M T_2 M	41,000	80,000	.00125	27.40	46.33	1 inch from end		
21175	3″.6 R 18 T—B T_1 M	49,000	87,000	.00150	24.00	44.58	$1\frac{1}{8}$ inches from end	Accepts 18.	
21183	B T_2 M	50,000	89,000	.00145	25.00	49.72	1 inch from end		
21179	M T_1 M	51,000	89,500	.00155	22.50	40.99	1 inch from end		
21162	M T_2 M	52,000	89,000	.00145	24.30	47.77	$\frac{3}{4}$ inch from end		
21180	3″.6 R 19 T—B T_1 M	50,000	89,000	.00150	24.00	44.58	1 inch from end	Accepts 19.	
21177	B T_2 M	47,000	87,250	.00150	22.30	46.33	$\frac{6}{8}$ inch from end		
21178	M T_1 M	54,000	90,500	.00170	24.80	46.03	$\frac{3}{4}$ inch from end		
21184	M T_2 M	52,000	90,500	.00155	22.50	46.03	$\frac{6}{8}$ inch from end		
21176	3″.6 R 20 T—B T_1 M	45,000	85,000	.00135	24.30	43.38	$\frac{3}{4}$ inch from end	Accepts 20.	
21185	B T_2 M	50,000	87,000	.00150	23.20	49.17	$\frac{6}{8}$ inch from end		
21158	M T_1 M	45,000	80,000	.00130	30.00	44.58	$1\frac{1}{8}$ inches from end		
21186	M T_2 M	49,000	85,000	.00160	25.00	51.97	$\frac{6}{8}$ inch from end		
21257	3″.6 R 21 T—B T_1 M	40,000	79,000	.00110 to .00170	27.00	46.33	$\frac{3}{4}$ inch from end	Accepts 21. Tube 22 rejected.	
21222	B T_2 M	41,000	80,500	.00125	27.50	51.42	1 inch from end		
21235	M T_1 M	43,000	79,500	.00125	31.20	46.33	1 inch from end		
21258	M T_2 M	42,000	79,250	.00120	28.40	41.89	$1\frac{1}{8}$ inches from end		

* Watertown number.

Midvale Steel Works.—Tensile tests for 3.6-inch B. L. rifle—Continued.

TABLE IX.—TUBES—Continued.

[Specimens 2 inches long between shoulders, diameter 0.505 inch, and 0.20 square inch cross section.]

Midvale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
21254	3″.6 R 23 T—B T_1 M	54,000	95,500	.00160	21.70	41.89	¾ inch from end	
21236	B T_2 M	54,000	94,000	.00165	24.00	44.88	¾ inch from end	Accepts 23.
21237	M T_1 M	55,000	94,500	.00180	21.50	43.08	1⅛ inches from end	
21255	M T_2 M	54,000	92,500	.00160	23.50	48.92	1 inch from end	
21238	3″.6 R 24 T—B T_1 M	44,000	81,000	.00130	28.00	51.12	1⅛ inches from end	
21274	B T_2 M	42,000	78,750	.00130	28.60	49.47	1⅛ inches from end	Accepts 24.
21273	M T_1 M	43,000	79,000	.00135	29.20	43.98	1⅛ inches from end	
21239	M T_2 M	41,000	79,250	.00105	26.70	41.89	⅞ inch from end	
21648	3″.6 R 25 T—B T_1 M	49,000	86,500	.00175	24.40	48.62	⅞ inch from end	
21623	B T_2 M	48,000	87,000	.00175	21.50	49.17	½ inch from end	Accepts 25.
21647	M T_1 M	50,000	86,500	.00195	24.00	41.58	$\frac{7}{10}$ inch from end	
21622	M T_2 M	45,000	84,000	.00175	26.70	41.28	⅞ inch from end	
21659	3″.6 R 26 T—B T_1 M	48,000	87,000	.00160	26.25	49.17	1 inch from end	
21621	B T_2 M	50,000	88,000	.00190	24.50	51.67	1⅛ inches from end	Accepts 26.
21660	M T_1 M	51,000	87,500	.00175	24.20	45.73	¾ inch from end	
21620	M T_2 M	47,000	84,500	.00175	26.50	44.33	$\frac{9}{10}$ inch from end	

TABLE X.—JACKETS.

20891	3″.6 R 1 J—B T_1 O	57,000	102,500	.00160	21.10	36.64	¾ inch from end	
20861	B T_3 M	50,000	96,000	.00155	18.80	34.09	⅝ inch from end	Accepts 1.
20862	M T_2 M	56,000	100,500	.00185	22.00	39.78	1 inch from end	
20892	M T_3 I	53,000	98,500	.00185	22.30	38.19	⅞ inch from end	Jacket 2 rejected.
20736	3″.6 R 3 J—B T_1 O	52,000	96,500	.00170	18.20	35.35	1 inch from end	
20709	B T_2 M	53,000	96,500	.00150	18.00	30.85	⅝ inch from end	Accepts 3.
20710	M T_1 M	53,000	94,500	.00160	24.80	46.33	1 inch from end	
20735	M T_2 I	49,000	93,500	.00140	18.00	30.85	1 inch from end	
20786	3″.6 R 4 J—B T_1 O	54,000	98,500	.00170	21.40	38.84	1 inch from end	
20737	B T_2 M	51,000	96,000	.00150	20.40	35.05	1 inch from end	Accepts 4.
20787	M T_1 M	52,000	95,000	.00155	22.70	44.58	1⅛ inches from end	
20754	M T_2 I	49,000	94,500	.00155	22.20	39.44	1 inch from end	Jacket 5 rejected.
20804	3″.6 R 6 J—B T_1 O	58,000	101,500	.00155	17.50	32.80	⅞ inch from end	
20777	B T_2 M	56,000	101,500	.00160	19.00	33.76	1 inch from end	Accepts 6.
20805	M T_1 M	57,000	102,500	.00160	17.30	30.50	⅞ inch from end	
20778	M T_2 I	53,000	99,500	.00175	20.00	33.45	1 inch from end	

20788	3″.6 R 7 J—B T_1 O	56,000	98,500	.00190	20.00	35.35	1 inch from end	Accepts 7.
20757	B T_2 M	54,000	99,500	.00190	17.00	31.50	1 inch from end	
20785	M T_1 M	52,000	100,500	.00155	20.30	36.64	1 inch from end	
20758	M T_3 I	52,000	99,500	.00175	20.80	37.24	1⅛ inches from end	
21129	3″.6 R 8 J—B T_1 O	47,000	86,500	.00140	21.50	38.53	1 inch from end	Accepts 8.
21168	B T_3 M	46,000	87,500	.00140	21.80	34.74	1 inch from end	
21130	M T_2 M	50,000	88,500	.00140	18.00	25.81	¾ inch from end	
21161	M T_3 I	48,000	87,500	.00150	19.00	31.15	1⅛ inches from end	
20816	3″.6 R 9 J—M T_1 M	49,000	97,000	.00150	21.20	38.19	1 inch from end	Accepts 9.
*4695	M T_2 I	49,000	97,900	.00190	17.50	30.70	$\frac{65}{100}$ inch from neck	
20890	B T_1 O	57,000	102,500	.00160	17.80	32.45	1¾ inches from end	
20815	B T_2 M	54,000	96,500	.00155	18.20	33.10	1 inch from end	
21131	3″.6 R 10 J—B T_1 O	48,000	86,750	.00149	21.60	35.05	¾ inch from end	Accepts 10.
21055	B T_3 M	51,000	91,000	.00150	25.00	41.28	¾ inch from end	
21056	M T_1 M	44,000	88,500	.00135	25.60	43.68	1⅛ inches from end	
21132	M T_2 I	48,000	89,500	.00140	25.00	43.38	1 inch from end	
20831	3″.6 R 11 J—B T_1 O	58,000	102,500	.00170	17.00	31.15	1 inch from end	Accepts 11.
20846	B T_2 M	53,000	99,500	.00160	17.50	25.46	1 inch from end	
20832	M T_1 M	54,000	100,550	.00180	19.60	39.74	1 inch from end	
20860	M T_2 I	59,000	98,000	.00165	20.60	41.89	1 inch from end	Accepts 12.
20863	3″.6 R 12 J—B T_1 O	56,000	101,500	.00165	21.30	39.47	1 inch from end	
20833	B T_2 M	56,000	101,000	.00180	19.00	37.24	1 inch from end	
20834	M T_1 M	53,000	101,000	.00155	21.00	35.05	1 inch from end	
*4696	M T_2 I	54,000	97,600	.00200	20.50	40.30	¾ inch from end	
21054	3″.6 R 13 J—B T_1 O	46,000	86,000	.00140	20.00	35.05	1 inch from end	Accepts 13.
21106	B T_3 M	46,000	85,000	.00135	20.00	36.64	1 inch from end	
21105	M T_2 M	48,000	87,750	.00136	27.30	46.03	1 inch from end	
21054	M T_3 I	46,000	88,750	.00145	26.80	44.58	1 inch from end	
20914	3″.6 R 14 J—B T_1 O	53,000	98,500	.00145	22.30	36.64	1⅞ inches from end	Accepts 14.
20880	B T_2 M	52,000	98,500	.00160	22.00	41.89	1⅞ inches from end	
20881	M T_1 M	53,000	97,000	.00155	22.70	40.69	1 inch from end	
*4708	M T_2 I	48,000	94,700	.00175	22.50	43.30	1$\frac{1}{10}$ inch from end	
20933	3″.6 R 15 J—B T_1 O	50,000	90,000	.00135	21.70	47.77	⅛ inch from end	Accepts 15.
20895	B T_2 M	54,000	95,000	.00155	18.00	30.85	¾ inch from end	
20905	M T_1 M	51,000	94,000	.00150	24.00	40.04	1 inch from end	
20925	M T_2 I	49,000	92,000	.00140	27.00	39.44	1¼ inches from end	
21142	3″.6 R 16 J—B T_1 O	47,000	86,500	.00130	19.60	30.85	$\frac{6}{10}$ inch from end	Accepts 16.
21058	B T_2 M	48,000	89,000	.00145	19.20	31.15	$\frac{5}{10}$ inch from end	
21133	M T_1 M	46,000	86,500	.00140	27.80	52.77	$\frac{8}{10}$ inch from end	
21059	M T_2 I	47,000	88,750	.00130	27.00	50.32	1 inch from end	
*4713	3″.6 R 17 J—B T_1 O	49,000	88,050	.00180	24.00	43.30	Middle of stem	Accepts 17.
21073	B T_2 M	49,000	89,500	.00145	22.80	40.69	1 inch from end	
21074	M T_1 M	48,000	89,000	.00140	25.80	50.57	1¼ inches from end	
21107	M T_2 I	49,000	87,000	.00150	26.00	51.97	1⅛ inches from end	
21199	3″.6 R 18 J—B T_1 O	53,000	90,000	.00145	24.00	43.98	¾ inch from end	Accepts 18.
21189	B T_3 M	48,000	86,750	.00145	22.50	36.00	¾ inch from end	
21188	M T_2 M	46,000	87,000	.00135	23.70	40.04	1⅛ inches from end	
21200	M T_3 I	47,000	88,500	.00140	25.00	42.48	1 inch from end	

* Watertown number.

Midvale Steel Works.—Tensile tests for 3.6-inch B. L. rifle—Continued.

TABLE X.—JACKETS—Continued.

[Specimens 2 inches long between shoulders, diameter 0.505 inch, and 0.20 square inch cross section. Contract of March 10, 1892.]

Midvale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
21134	3″.6 R 19 J—B T_1 O	49,000	88,000	.00155	25.40	46.33	1 inch from end	Accepts 19.
21103	B T_2 M	48,000	89,500	.00130	25.40	42.78	$1\frac{1}{8}$ inches from end	
21104	M T_1 M	50,000	87,500	.00140	27.40	51.12	1 inch from end	
*4714	M T_2 I	47,000	87,050	.00160	24.50	43.30	$1\frac{1}{10}$ inches from end	
21167	3″.6 R 20 J—B T_1 O	52,000	92,000	.00155	24.00	46.88	1 inch from end	Accepts 20.
21135	B T_2 M	49,000	89,500	.00150	22.50	40.04	$1\frac{1}{8}$ inches from end	
21136	M T_1 M	50,000	90,000	.00165	24.60	49.72	1 inch from end	
21160	M T_2 I	46,000	87,000	.00130	26.40	48.32	1 inch from end	
21169	3″.6 R 21 J—B T_1 O	48,000	87,000	.00140	22.50	41.58	1 inch from end	Accepts 21.
21143	B T_2 M	45,000	86,000	.00130	26.20	43.08	1 inch from end	
21144	M T_1 M	47,000	87,500	.00140	25.50	46.63	$1\frac{1}{8}$ inches from end	
21170	M T_2 I	46,000	86,250	.00135	22.70	32.45	1 inch from end	
21201	3″.6 R 22 J—B T_1 O	50,000	89,000	.00155	23.88	47.18	$\frac{3}{4}$ inch from end	Accepts 22.
21191	B T_2 M	49,000	87,500	.00130	24.70	42.78	$\frac{7}{8}$ inch from end	
21190	M T_1 M	48,000	86,500	.00145	26.40	47.77	1 inch from end	
21202	M T_2 I	45,000	86,000	.00130	24.40	42.78	$\frac{5}{8}$ inch from end	
21209	3″.6 R 23 J—B T_1 O	56,000	102,000	.00160	19.20	38.49	$\frac{5}{8}$ inch from end	Accepts 23.
21233	B T_2 M	56,000	104,000	.00185	17.50	31.15	$\frac{5}{8}$ inch from end	
21234	M T_1 M	53,000	100,000	.00155	18.70	37.89	1 inch from end	
21210	M T_2 I	56,000	102,000	.00170	20.50	36.64	$\frac{7}{8}$ inch from end	
21231	3″.6 R 24 J—B T_1 O	54,000	97,000	.00165	19.20	30.85	$1\frac{1}{8}$ inches from end	Accepts 24.
21211	B T_2 M	51,000	94,500	.00150	20.40	37.89	1 inch from end	
21212	M T_1 M	52,000	95,500	.00155	19.60	31.80	$\frac{3}{4}$ inch from end	
21232	M T_2 I	53,000	96,500	.00155	19.00	38.19	$\frac{5}{8}$ inch from end	
21470	3″.6 R 25 J—B T_1 O	59,000	97,500	.00160	22.50	46.88	$\frac{3}{4}$ inch from end	Accepts 25.
21452	B T_2 M	56,000	96,500	.00170	20.00	31.50	$\frac{7}{8}$ inch from end	
21453	M T_1 M	58,000	100,000	.00165	19.60	35.05	1 inch from end	
21474	M T_2 I	59,000	97,000	.00150	22.80	39.44	$\frac{7}{8}$ inch from end	
21477	3″.6 R 26 J—B T_1 O	60,000	97,500	.00150	21.00	41.58	$\frac{5}{8}$ inch from end	Accepts 26.
21454	B T_2 M	58,000	98,500	.00165	19.70	36.30	$\frac{3}{4}$ inch from end	
21455	M T_1 M	57,000	99,500	.00170	21.00	38.84	1 inch from end	
21475	M T_2 I	59,000	98,000	.00175	23.80	38.49	1 inch from end	

* Watertown number.

Midvale Steel Works.—Tensile tests for 3.6-inch B. L. rifled field gun.

TABLE XI.—BREECH MECHANISM.

[Specimens 2 inches long between shoulders, diameter 0.505 inch, and 0.20 square inch cross section. Contract of March 10, 1892.]

	(a) Breechblocks.							
20713	3″.6 R 1 B B—T_2 M	45,000	84,750	{.00140 .00200}	23.90	37.24	$\frac{7}{8}$ inch from end	Accepts 1, 2, 3, 4, and 5 B B.
20722	3″.6 R 6 B B—T_1 M	48,000	86,500	.00145	27.00	43.38	1 inch from end	Accepts 6, 7, and 8 B B.
20697	3″.6 R 9 B B—T_1 M	51,000	90,000	.00170	20.00	34.40	$1\frac{1}{8}$ inches from end	Accepts 9, 10, 11, 12, and 13 B B.
20711	3″.6 R 14 B B—T_1 M	45,000	85,000	{.00135 .00210}	23.70	35.35	1 inch from end	Accepts 14, 15, 16, 17, and 18 B B.
20712	3″.6 R 24 B B—T_1 M	49,000	88,500	.00150	22.00	39.74	1 inch from end	Accepts 19, 20, 21, 22, 23, and 24 B B.
	(b) Spindles.							
20604	3″.6 R 1 Sp—L_1	45,000	85,500	.00140	24.20	59.86	$\frac{3}{16}$ inch from end	Accepts 1, 2, 3, 4, and 5 Sp.
20663	3″.6 R 6 Sp—L_1	46,000	87,000	.00145	28.70	58.86	$\frac{3}{4}$ inch from end	Accepts 6, 7, 8, 9, and 10 Sp.
20664	3″.6 R 11 Sp—L_1	45,000	86,250	.00140	28.70	58.86	$1\frac{1}{4}$ inches from end	Accepts 11, 12, 13, 14, and 15 Sp.
20632	3″.6 R 16 Sp—L_1	52,000	87,500	.00160	25.00	60.61	$\frac{1}{16}$ inch from end	Accepts 16, 17, 18, 19, and 20 Sp.
20631	3″.6 R 24 Sp—L_1	47,000	83,000	.00145	29.40	58.86	$\frac{3}{16}$ inch from end	Accepts 21, 22, 23, and 24 Sp.
	(c) Gas-check cups.							
20909	3″.6 R 1 G C—T_1 M	84,000	140,500	.00210	16.00	36.94	$\frac{3}{4}$ inch from end	Accepts 1, 2, 3, 4, and 5 A and B.
20931	3″.6 R 6 G C—T_1 M	88,000	143,750	.00250	16.40	33.96	$1\frac{1}{8}$ inches from end	Accepts 6, 7, 8, 9, and 10 A and B.
20930	3″.6 R 11 G C—T_1 M	87,000	143,000	.00240	14.40	32.80	1 inch from end	Accepts 11, 12, 13, and 14 A and B.
20924	3″.6 R 15 G C—T_1 M	88,000	145,500	.00255	14.50	31.80	$\frac{5}{8}$ inch from end	Accepts 15, 16, 17, 18, and 19 A and B.
20932	3″.6 R 24 G C—T_1 M	92,000	144,500	.00255	15.00	32.15	1 inch from end	Accepts 20, 21, 22, 23, and 24 A and B.

Midvale Steel Works.—Tensile tests for 3.6-inch B. L. rifled mortar carriages.

TABLE XII.—STEEL CASTINGS.*

[Contract of June 8, 1891.]

17283	3″.6 M R 18 C—L_1 R	30,000	59,500	.....	28.10	50.32	.....	Accepts 18.
17282	3″.6 M R 18 C—L_1 L	29,000	57,750	.....	25.00	40.99	.....	
17379	3″.6 M R 19 C—L_1 R	30,500	64,500	.....	26.30	46.63	.....	Accepts 19.
17380	3″.6 M R 19 C—L_1 L	35,000	67,500	.....	26.50	45.13	.....	
17381	3″.6 M R 20 C—L_1 R	34,500	67,500	.....	27.00	38.19	.....	Accepts 20 and elevating arcs 20, 21, 22, and 23.
17382	3″.6 M R 20 C—L_1 L	37,000	68,000	.....	26.30	42.48	.....	

*Continued from page 351, Report of Chief of Ordnance.

Midvale Steel Works.— Tensile tests for 3.6-inch B. L. rifled mortar carriages—Continued.

TABLE XII.—STEEL CASTINGS*—Continued.

[Contract of June 8, 1891.]

Mid-vale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
19812	3″.6 M R 21 C—L_1 R	29,000	61,000	.....	20.00	49.17	.....	Accepts 21.
19818	3″.6 M R 21 C—L_1 L	36,000	55,750	.....	29.00	40.69	.....	
19975	3″.6 M R 22 C—L_1 R	35,000	68,000	.....	25.50	31.80	.....	Accepts 22.
19976	3″.6 M R 22 C—L_1 L	38,500	65,750	.....	26.40	43.98	.....	
19969	3″.6 M R 23 C—L_1 R	32,500	63,000	.....	28.80	48.92	.....	Accepts 23.
19970	3″.6 M R 23 C—L_1 L	33,000	59,100	.....	26.20	40.69	.....	
21301	3″.6 M R 24 C—L_2 R	32,500	63,000	.....	9.00	13.38	Defective specimen; sand spot	Accepts 24.
21300	3″.6 M R 24 C—L_2 L	34,000	66,000	.....	25.00	40.69	.....	
21217	3″.6 M R 25 C—L_1 R	31,000	64,500	.....	31.00	54.66	.....	Accepts 25.
21218	3″.6 M R 25 C—L_1 L	32,000	65,000	.....	27.00	36.00	.....	
21602	3″.6 M R 26 C—L_1 R	32,500	70,000	.....	24.50	34.40	.....	Accepts 26; rejected afterwards for blowholes.
21612	3″.6 M R 26 C—L_1 L	35,000	68,500	.....	21.25	28.16	.....	
21679	3″.6 M R 27 C—L_1 R	30,000	60,000	.....	27.70	52.22	.....	Accepts 27 and elevating arcs 30, 31, and 32.
21680	3″.6 M R 27 C—L_1 L	30,000	61,500	.....	26.25	43.08	.....	
21677	3″.6 M R 28 C—L_1 R	29,000	60,750	.....	24.10	50.32	.....	Accepts 28 and elevating arcs 24, 25, 26, 27, 28, and 29.
21678	3″.6 M R 28 C—L_1 L	30,000	61,250	.....	22.00	44.58	.....	
21882	3″.6 M R 29 C—L_1 R	29,500	64,000	.....	18.00	24.76	.....	Accepts 29 and ratchet wheel and pawl for 8-inch carriage.
21881	3″.6 M R 29 C—L_1 L	27,500	61,500	.....	28.20	33.10	.....	
22196	3″.6 M R 30 C—L_1 R	35,000	71,000	.....	20.50	35.70	.....	Accepts 30.
22195	3″.6 M R 30 C—L_1 L	34,000	69,000	.....	22.00	37.59	.....	
22197	3″.6 M R 31 C—L_1 R	35,250	70,500	.....	24.80	40.34	.....	Accepts 31, also elevating arcs 33, 34, 35, 36, 37, and 38.
22198	3″.6 M R 31 C—L_1 L	35,000	72,400	.....	20.00	34.09	.....	
22379	3″.6 M R 32 C—L_1 R	31,000	69,000	.....	28.00	46.03	.....	Accepts 32.
22380	3″.6 M R 32 C—L_1 L	30,500	67,500	.....	25.50	28.16	.....	

* Continued from page 351, Report of Chief of Ordnance.

Midvale Steel Works—Tensile tests for 8-inch B. L. steel rifles.

TABLE XIII.—TUBES.

[Specimens 3 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section. Contract of June 15, 1891.]

20637	8 R 1 T—B T_1 O	47,000	90,800	.00225	17.10	31.14	1½ inches from end	Accepts 8-inch tube No. 1.
20638	B T_5 M	43,000	82,520	.00220	5.50	7.65	At neck	
20616	B T_6 I	45,000	88,000	.00215	18.20	30.55	1⅝ inches from end	
20655	B T_7 M	43,000	87,200	.00175	17.20	34.64	1⅛ inches from end; an extra bar taken to replace B T_5 M.	
20653	M T_1 O	42,000	83,200	.00190	26.70	41.61	1 inch from end	
20654	M T_2 M	45,000	86,800	.00220	16.60	30.85	1¼ inches from end	
20622	M T_5 I	48,000	86,800	.00215	19.20	40.25	¾ inch from end	
20465	8 R 2 T—B T_1 O	48,000	88,400	.00143	17.00	26.66	1 inch from end	
20452	B T_2 M	45,000	88,640	.00143	17.67	31.14	1 inch from end	
20466	B T_3 I	49,000	91,600	.00143	17.60	34.05	1¼ inches from end	Accepts 8-inch tube No. 2.
20490	M T_1 O	41,000	82,400	.00137	18.83	32.61	¾ inch from end	
20453	M T_2 M	43,000	83,600	.00117	24.00	45.34	1⅜ inches from end	
20491	M T_3 I	43,000	81,600	.00123	18.00	38.58	1¼ inches from end	
20532	8 R 3 T—B T_1 O	45,000	88,800	.00210	19.10	33.19	1⅛ inches from end	
20520	B T_2 M	44,000	86,400	.00190	19.20	30.85	¾ inch from end	
20548	B T_3 I	40,000	82,000	.00200	18.00	33.76	⅝ inch from end	Accepts 8-inch tube No. 3.
20531	M T_1 O	45,000	85,440	.00220	22.10	36.63	1⅝ inches from end	
20514	M T_2 M	45,000	84,800	.00220	20.60	32.02	1¼ inches from end	
20528	M T_3 T	46,000	86,000	.00230	20.00	35.78	1½ inches from end	
20671	8 R 4 T—B T_1 O	48,000	90,800	.00240	18.10	37.75	1⅛ inches from end	
20649	B T_2 M	46,000	89,600	.00245	17.10	33.76	1 inch from end	
20672	B T_3 I	48,000	89,600	.00235	17.20	33.76	1½ inches from end	Accepts 8-inch tube No. 4.
20666	M T_1 O	52,000	89,600	.00260	18.00	33.48	½ inch from end	
20648	M T_2 M	47,000	88,600	.00220	21.40	40.79	¾ inch from end	
20665	M T_3 I	52,000	90,400	.00255	14.00	21.72	1½ inches from end	
20751	8 R 5 T—B T_1 O	47,000	92,800	.00153	19.50	38.30		
20724	B T_2 M	46,000	89,400	.00153	17.10	27.26		
20750	B T_3 I	47,000	88,200	.00153	18.80	32.90		Accepts 8-inch tube No. 5.
20781	M T_1 O	50,000	89,200	.00173	20.30	42.15		
20723	M T_2 M	50,000	90,000	.00157	22.20	42.42		
20782	M T_3 I	52,000	89,600	.00150	18.50	35.78		
20806	8 R 6 T—B T_1 O	50,000	95,200	.00167	17.00	30.55		
20779	B T_2 M	43,000	86,000	.00137	17.20	35.78		
20807	B T_3 I	44,000	87,600	.00153	17.40	32.32		Accepts 8-inch tube No. 6.
20808	M T_1 O	49,000	90,400	.00147	19.30	39.96		
20780	M T_2 M	49,000	92,800	.00163	20.50	34.64		
20809	M T_3 I	51,000	91,600	.00170	17.60	30.85		
21095	8 R 7 T—B T_1 O	46,000	87,200	.00143	19.00	38.30	1¼ inches from end	
21093	B T_2 M	44,000	80,800	.00113	12.00	23.58	½ inch from end	
21096	B T_3 I	46,000	87,400	.00150	17.20	28.47	¾ inch from end	Accepts 8-inch tube No. 7.
21120	M T_1 O	47,000	87,200	.00150	25.60	45.86	1 inch from end	
21091	M T_2 M	48,000	87,600	.00143	33.10	44.54	1½ inches from end	
21121	M T_3 I	49,000	87,400	.00150	26.47	42.42	1¾ inches from end	

Midvale Steel Works.—Tensile tests for 8-inch B. L. steel rifles—Continued.

TABLE XIII.—TUBES—Continued.

[Specimens 3 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section. Contract of June 15, 1891.]

Mid-vale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
21266	8 R 8 T—B T_1 O	45,000	86,800	.00147	17.50	30.55	1 inch from end	Accepts 8-inch tube No. 8.
21240	B T_2 M	44,000	86,000	.00143	20.40	30.25	1⅛ inches from end	
21267	B T_3 I	45,000	85,600	.00150	20.10	36.34	1 inch from end	
21268	M T_1 O	48,000	86,800	.00160	21.80	40.79	1⅜ inches from end	
21241	M T_2 M	47,000	86,600	.00143	17.10	32.61	⅝ inch from end	
21269	M T_3 I	48,000	85,800	.00173	17.70	36.63	1½ inches from end	
21783	8 R 9 T—B T_1 O	50,000	87,200	.00167	18.00	33.48	⅝ inch from end	
21745	B T_2 M	43,000	80,000	.00117	19.00	35.49	⅝ inch from end	
21782	B T_3 I	44,000	80,000	.00163	20.27	42.42	1½ inches from end	
21789	M T_1 O	43,000	82,600	.00140	16.67	16.62	1¼ inches from end	Accepts 8-inch tube No. 9.
21818	M T_4 O	45,000	84,000	.00147	25.27	43.22	¾ inch from end	
21746	M T_2 M	44,000	83,200	.00127	22.50	36.06	1¼ inches from end	
21788	M T_3 I	43,000	82,800	.00133	17.50	26.45	1½ inches from end	
21810	8 R 10 T—B T_1 O	45,000	85,600	.00137	17.80	40.79	¾ inch from end	
21754	B T_2 M	45,000	84,800	.00157	20.20	39.41	1⅝ inches from end	
21811	B T_3 I	47,000	86,400	.00143	21.53	37.75	1½ inches from end	Accepts 8-inch tube No. 10.
21785	M T_1 O	42,000	82,800	.00123	25.33	36.06	1⅝ inches from end	
21753	M T_2 M	41,000	81,600	.00113	20.70	32.61	⅜ inch from end	
21784	M T_3 I	42,000	80,800	.00150	21.53	28.17	1⅜ inches from end	
*4783	8 R 11 T—B T_1 O	45,000	88,280	.00147	18.00	27.60	1⅛ inches from end	
22070	B T_3 M	45,000	84,800	.00147	21.30	45.60	1 inch from end	
22080	B T_5 I	43,000	80,080	.00120	24.00	41.88	1 inch from end	Accepts 8-inch tube No. 11.
*4784	M T_1 O	39,000	78,880	.00133	25.30	44.60	1⅓ inches from end	
22071	M T_3 M	43,000	80,400	.00133	21.20	28.47	1½ inches from end	
22079	M T_4 I	42,000	80,000	.00100	21.00	27.87	1 inch from end	

* Watertown number.

TABLE XIV.—JACKETS.

[Specimens 3 inches long between shoulders, diameter 0.565 inch, and 0.25 square inch cross section. Contract of June 15, 1891.]

20600	8 R 1 J—B T_5 O	54,000	98,400	.00157	14.30	26.96	1¼ inches from end	Accepts 8-inch jacket No. 1.
20592	B T_6 M	46,000	87,600	.00133	20.00	33.76	1⅛ inches from end	
20603	B T_7 I	47,000	91,600	.00147	18.30	32.90	1 inch from end	
20603	M T_5 O	53,000	94,000	.00173	19.73	36.91	1 inch from end	
20593	M T_6 M	53,000	93,200	.00157	17.00	31.14	¾ inch from end	
20601	M T_7 I	55,000	94,400	.00177	20.50	43.75	1⅝ inches from end	
20437	8 R 2 J—B T_1 O	55,000	98,800	.00157	19.70	47.15	1¼ inches from end	Accepts 8-inch jacket No. 2.
20438	B T_2 M	49,000	92,000	.00147	15.00	18.23	1⅓ inches from end	
20428	B T_3 I	51,000	88,000	.00163	23.50	51.94	1½ inches from end	
20439	M T_1 O	52,000	89,200	.00160	22.80	47.15	1⅜ inches from end	
20440	M T_2 M	48,000	88,400	.00173	20.50	36.63	1 inch from end	
20417	M T_3 I	55,000	92,400	.00170	19.50	40.25	1⅝ inches from end	
20580	8 R 3 J—B T_1 O	53,000	95,600	.00200	21.00	43.22	1¼ inches from end	Accepts 8-inch jacket No. 3.
20550	B T_2 M	46,000	88,800	.00153	20.00	41.61	1 inch from end	
20577	B T_3 I	49,000	90,000	.00160	22.30	41.34	1 inch from end	
20581	M T_1 O	49,000	89,200	.00150	20.00	38.86	1¼ inches from end	
20549	M T_2 M	55,000	93,600	.00163	22.80	47.15	1⅜ inches from end	
20582	M T_3 I	50,000	89,200	.00140	17.50	26.96	1¼ inches from end	
20669	8 R 4 J—B T_1 O	54,000	91,600	.00140	21.50	46.12	1 inch from end	Accepts 8-inch jacket No. 4.
20635	B T_2 M	49,000	91,840	.00137	16.20	30.85	1½ inches from end	
20662	B T_3 I	50,000	88,400	.00160	19.40	32.90	1 inch from end	
20670	M T_1 O	56,000	94,400	.00170	21.20	44.02	1⅜ inches from end	
20636	M T_2 M	55,000	92,000	.00170	18.40	42.69	⅝ inch from end	
20676	M T_3 I	58,000	94,800	.00190	20.00	44.54	1½ inches from end	
20966	8 R 5 J—B T_1 O	53.000	92,800	.00167	21.20	47.66	1⅓ inches from end	Accepts 8-inch jacket No. 5.
20942	B T_2 M	48,000	90,000	.00147	16.20	29.66	¾ inch from end	
20967	B T_3 I	50,000	89,600	.00153	10.70	15.00	¾ inch from end	
20973	B T_4 M I	49,000	88,000	.00147	16.40	27.87	⅝ inch from end	
20968	M T_1 O	47,000	84,000	.00137	25.70	43.49	1¾ inches from end	
20943	M T_2 M	51,000	90,400	.00157	18.40	37.19	1⅝ inches from end	
20972	M T_3 I	51,000	86,080	.00147	17.20	34.05	½ inch from end	
21027	8 R 6 J—B T_1 O	49,000	89,200	.00140	23.50	48.70	1 inch from end	Accepts 8-inch jacket No. 6.
21003	B T_1 M	47,000	86,400	.00153	21.20	31.73	1⅝ inches from end	
21028	B T_3 I	46,000	87,600	.00147	22.10	39.96	1 inch from end	
21016	M T_1 O	44,000	83,200	.00140 to .00170	25.80	39.14	1⅛ inches from end	
21004	M T_2 M	44,000	84,000	.00140 to .00173	25.60	38.30	1⅛ inches from end	
21020	M T_3 I	44,000	86,000	.00200 to .00267	23.40	39.14	1⅝ inches from end	
21114	8 R 7 J—B T_1 O	54,000	95,200	.00163	20.90	46.64	1¼ inches from end	Accepts 8-inch jacket No. 7.
21115	B T_3 T	49,000	92,000	.00157	19.60	32.90	1 inch from end	
21116	B T_4 M	50,000	92,400	.00153	14.10	27.56	⅛ inch from end	
21117	M T_1 O	48,000	91,600	.00137	21.20	45.07	⅝ inch from end	
21118	M T_3 I	50,000	92,000	.00160	19.00	40.79	¾ inch from end	
21119	M T_4 M	51,000	91,600	.00163	20.80	45.86	1 inch from end	

Midvale Steel Works.—Tensile tests for 8-inch B. L. steel rifles—Continued.

TABLE XIV.—JACKETS—Continued.

[Specimens 3 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section. Contract of June 15, 1891.]

Midvale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
21324	8 R 8 J—B T_1 O	56,000	98,800	.00173	17.30	34.92	¾ inch from end	Accepts 8-inch jacket No. 8.
21307	B T_2 M	49,000	93,600	.00167	19.00	25.43	1½ inches from end	
21325	B T_3 I	53,000	94,800	.00177	14.00	22.34	½ inch from end	
21326	M T_1 O	52,000	92,000	.00173	18.00	31.14	½ inch from end	
21308	M T_2 M	53,000	94,000	.00163	20.50	43.22	1½ inches from end	
21327	M T_3 I	54,000	92,200	.00177	17.60	39.41	¾ inch from end	
*4721	8 R 9 J—B T_1 O	50,000	92,320	.00167	19.30	33.50	$\frac{9}{10}$ inch from neck	
21343	B T_2 M	46,000	84,000	.00153	18.00	36.34	1 inch from end	Accepts 8-inch jacket No. 9.
21360	B T_3 I	46,000	83,600	.00143	17.00	31.14	1 inch from end	
*4722	M T_1 O	50,000	84,680	.00177	23.30	47.20	$1\frac{7}{10}$ inches from end	
21344	M T_2 M	49,000	87,600	.00170	18.00	30.55	1½ inches from end	
21361	M T_3 I	50,000	86,400	.00173	15.00	32.02	¾ inch from end	
21848	8 R 10 J—B T_1 O	52,000	93,200	.00173	21.83	46.38	1½ inches from end	
21846	B T_2 M	50,000	92,000	.00173	13.87	20.15	⅞ inch from end	
21832	B T_4 I	50,000	89,200	.00170	16.40	25.43	1¼ inches from end	Accepts 8-inch jacket No. 10.
21852	M T_1 O	45,000	85,520	.00130	27.00	47.40	1½ inches from end	
21849	M T_2 M	46,000	85,600	.00167	21.83	46.20	¾ inch from end	
21833	M T_4 M	50,000	88,400	.00163	19.67	45.86	½ inch from end	
21868	8 R 11 J—B T_1 O	57,000	95,600	.00190	17.20	32.90	⅞ inch from end	Accepts jacket No. 11.
*4758	B T_2 M	42,000	87,440	.00147	23.30	49.70	1⅜ inches from end	
21850	B T_3 I	51,000	89,200	.00180	21.00	45.86	⅞ inch from end	
21866	M T_1 O	51,000	87,200	.00153	21.00	30.25	1⅜ inches from end	
*4757	M T_2 M	47,000	93,480	.00177	21.30	44.60	1¼ inches from end	
21851	M T_3 I	57,000	90,400	.00200	18.53	40.25	¾ inch from end	

* Watertown number.

TABLE XV.—TRUNNION HOOPS.

[Specimens 4 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section. Contract of June 15, 1891.]

18504	8 R 1 T H—T_1 O	57,000	103,600	.00178	16.90	40.25	1 inch from end	Accepts 8-inch trunnion hoop No. 1.
18463	T_2 M	53,000	102,000	.00175	15.50	22.91	1¾ inches from end	
18516	T_3 I	57,000	105,400	.00178	15.30	38.30	1 inch from end	
18480	8 R 2 T H—T_1 O	54,000	97,600	.00180	19.70	45.86	1⅛ inches from end	Accepts 8-inch trunnion hoop No. 2.
18445	T_2 M	53,000	101,200	.00155	14.70	22.96	2 inches from end	
18492	T_3 I	58,000	102,400	.00190	18.00	46.89	2 inches from end	
18619	8 R 3 T H—T_1 O	55,000	102,400	.00185	16.60	39.96	1⅛ inches from end	Accepts 8-inch trunnion hoop No. 3.
18574	T_2 M	57,000	100,800	.00157	17.70	37.19	1¼ inches from end	
18620	T_3 I	54,000	102,000	.00155	19.40	38.86	1⅜ inches from end	
18596	8 R 4 T H—T_1 O	56,000	100,000	.00180	19.30	45.07	1½ inches from end	Accepts 8-inch trunnion hoop No. 4.
18567	T_2 M	54,000	101,600	.00180	18.20	32.90	2 inches from end	
18597	T_3 I	54,000	101,600	.00172	18.50	42.42	1½ inches from end	
20908	8 R 5 T H—T_1 O	55,000	98,000	.00160	18.55	49.71	1⅛ inches from end	Accepts 8-inch trunnion hoop No. 5.
20879	T_2 M	53,000	100,800	.00162	14.60	30.55	1¾ inches from end	
20913	T_3 I	55,000	101,200	.00155	18.00	46.12	1⅛ inches from end	
20956	8 R 6 T H—T_1 O	57,000	101,200	.00173	18.00	47.40	⅞ inch from end	Accepts 8-inch trunnion hoop No. 6.
20927	T_2 M	57,000	105,600	.00160	13.10	21.72	1⅝ inches from end	
20955	T_3 I	60,000	105,600	.00177	19.00	52.65	1⅝ inches from end	
21039	8 R 7 T H—T_1 O	55,000	102,400	.00175	15.30	34.05	1¼ inches from end	Accepts 8-inch trunnion hoop No. 7.
21009	T_2 M	53,000	100,800	.00160	14.00	25.13	½ inch from end	
21040	T_3 I	57,000	104,000	.00175	17.20	40.79	1½ inches from end	
21171	8 R 8 T H—T_1 O	55,000	96,800	.00167	20.00	48.94	1¾ inches from end	Accepts 8-inch trunnion hoop No. 8.
21152	T_2 M	52,000	96,000	.00163	20.50	49.71	1¾ inches from end	
21174	T_3 I	54,000	96,800	.00165	19.70	49.20	1¾ inches from end	
21373	8 R 9 T H—T_1 O	57,000	104,000	.00182	17.10	44.81	2 inches from end	Accepts 8-inch trunnion hoop No. 9.
21346	T_2 M	57,000	107,200	.00182	18.10	32.02	1¼ inches from end	
21362	T_3 I	59,000	104,800	.00187	19.00	45.34	2 inches from end	
21510	8 R 10 T H—T_1 O	54,000	93,600	.00167	19.50	50.46	1⅛ inches from end	Accepts 8-inch trunnion hoop No. 10.
21293	T_2 M	50,000	94,800	.00147	19.70	46.38	1⅛ inches from end	
21511	T_3 I	53,000	94,000	.00160	21.90	43.64	1¼ inches from end	
21987	8 R 11 T H—T_1 O	59,000	104,400	.00157	17.60	43.49	1¼ inches from end	Accepts 8-inch trunnion hoop No. 11.
21977	T_2 M	55,000	104,000	.00175	17.70	31.14	2 inches from end	
21992	T_3 I	58,000	103,200	.00160	17.80	42.15	2 inches from end	

Midvale Steel Works.—Tensile tests for 8-inch B. L. steel rifles—Continued.

TABLE XVI.—HOOPS A_1 AND A_3.

[Specimens 3 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section. Contract of June 15, 1891.]

Midvale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
20190	8 R 1 A_1—T_4 O	56,000	104,400	.00177	17.60	35.49	1⅝ inches from end	Accepts hoops A_1 Nos. 1 and 2.
20128	T_5 M	53,000	98,400	.00183	18.40	31.43	1⅜ inches from end	
20191	T_6 I	59,000	100,000	.00200	18.53	40.52	¾ inch from end	
20264	8 R 3 A_1—T_1 O	59,000	104,400	.00170	15.30	23.89	1½ inches from end	Accepts hoops A_1 Nos. 3 and 4.
20218	T_2 M	53,000	98,400	.00163	17.70	29.66	1⅝ inches from end	
20263	T_3 I	51,000	94,400	.00173	20.70	46.89	1½ inches from end	
21159	8 R 5 A_1—T_1 O	57,000	96,800	.00170	21.73	47.92	1⅝ inches from end	Accepts hoops A_1 Nos. 5, 6, 7, and 8.
21157	T_3 I	57,000	96,400	.00180	19.00	41.88	1⅝ inches from end	
21127	T_4 M	54,000	96,800	.00167	18.00	40.52	1 inch from end	
21108	8 R 11 A_1—T_1 O	54,000	100,800	.00183	16.70	22.96	1⅓ inches from end	Accepts hoops A_1 Nos. 9, 10, and 11.
21092	T_2 M	56,000	102,000	.00167	16.40	28.47	⅝ inch from end	
21109	T_3 I	60,000	108,600	.00207	14.40	23.27	⅝ inch from end	
21974	8 R 12 A_1—T_1 O	67,000	112,400	.00207	16.00	29.96	1¼ inches from end	Accepts hoop A_1 No. 12.
21975	T_3 M	63,000	108,400	.00187	17.40	35.49	1½ inches from end	
21960	T_4 I	61,000	108,400	.00203	17.73	30.55	1 inch from end	
20245	8 R 1 A_3—T_1 O	57,000	106,400	.00200	15.00	23.58	1⅓ inches from end	Accepts hoop A_3 No. 1.
20199	T_3 M	53,000	100,800	.00167	14.40	22.96	1⅛ inches from end	
20249	T_4 I	52,000	96,800	.00163	19.00	36.34	1½ inches from end	
20346	8 R 2 A_3—T_1 O	55,000	107,200	.00173	15.20	24.51	1½ inches from end	Accepts hoop A_3 No. 2.
20295	T_4 M	53,000	108,000	.00177	15.10	25.13	1⅝ inches from end	
20347	T_5 I	57,000	107,600	.00187	15.10	31.14	¾ inch from end	
20409	8 R 3 A_3—T_1 O	57,000	107,600	.00177	15.00	30.85	1 inch from end	Accepts hoop A_3 No. 3.
20359	T_3 M	50,000	100,400	.00160	14.00	30.55	¾ inch from end	
20408	T_4 I	52,000	97,200	.00173	19.60	38.03	1 inch from end	
20576	8 R 4 A_3—T_4 O	58,000	105,200	.00173	17.33	34.03	1 inch from end	Accepts hoop A_3 No. 4.
20533	T_5 M	55,000	106,800	.00183	16.00	30.55	1⅛ inches from end	
20578	T_6 I	63,000	108,000	.00207	15.20	35.21	1⅛ inches from end	
20783	8 R 5 A_3—T_1 O	56,000	99,600	.00173	20.10	40.79	1 inch from end	Accepts hoops A_3 Nos. 5 and 6.
20738	T_2 M	56,000	106,400	.00173	16.60	32.61	1 inch from end	
20784	T_3 I	57,000	103,600	.00173	19.40	31.73	1⅛ inches from end	
20957	8 R 7 A_3—T_1 O	54,000	96,000	.00167	21.50	50.96	1½ inches from end	Accepts hoops A_3 Nos. 7 and 8.
20929	T_2 M	50,000	95,000	.00140 to .00160	22.40	40.52	1⅜ inches from end	
20958	T_3 I	54.000	94,000	.00157	19.00	32.02	1 inch from end	

21807	8 R 9 A_3—T_1 O	Just below 50,000	91,600	.00167 .01073	23.33	37.47	1½ inches from end	Accepts hoops A_3 Nos. 9 and 10. Hoop A_3 No. 11, was accepted on test of hoop A_4 No. 11.
21790	T_2 M	53,000	98,400	.00183	16.93	23.27	1⅜ inches from end	
21808	T_3 I	55,000	96,800	.00200	13.33	14.34	1⅜ inches from end	

TABLE XVII.—HOOPS A_4.

19985	8 R 1 A_4—T_1 O	57,000	101,600	.00190	18.93	40.25	1½ inches from end	Accepts 8-inch hoop A_4 No. 1.
19956	T_2 M	50,000	100,000	.00160	14.53	24.82	⅞ inch from end	
19987	T_3 I	56,000	102,800	.00177	16.70	28.47	⅞ inch from end	
20151	8 R 2 A_4—T_1 O	59,000	106,000	.00160	18.37	34.92	1½ inches from end	Accepts 8-inch hoop A_4 No. 2.
20063	T_2 M	54,000	105,600	.00187	16.90	35.49	1 inch from end	
20150	T_3 I	54,000	102,800	.00163	14.00	15.65	1¼ inches from end	
20383	8 R 3 A_4—T_1 O	57,000	105,600	.00207	15.20	23.89	1¼ inches from end	Accepts 8-inch hoop A_4 No. 3.
20348	T_2 M	53,000	104,000	.00177	14.20	23.89	1¼ inches from end	
20384	T_3 I	58,000	104,800	.00183	16.00	26.96	1⅛ inches from end	
20510	8 R 4 A_4—T_1 O	56,000	104,000	.00177	15.40	31.43	⅝ inch from end	Accepts 8-inch hoop A_4 No. 4.
20421	T_2 M	52,000	104,000	.00160	14.00	21.41	1⅝ inches from end	
20507	T_3 I	55,000	103,600	.00183	15.50	30.25	⅛ inch from end	
20728	8 R 5 A_4—T_1 O	56,000	94,400	.00157	21.33	43.75	1⅝ inches from end	Accepts 8-inch hoops A_4 Nos. 5 and 6.
20694	T_2 M	50,000	94,800	.00163	16.60	30.85	1 inch from end	
20725	T_3 I	53,000	92,400	.00163	19.20	37.75	1½ inches from end	
20857	8 R 7 A_4—T_1 O	59,000	103,200	.00193	19.40	39.96	1¼ inches from end	Accepts 8-inch hoops A_4 Nos. 7 and 8.
20803	T_2 M	53,000	106,000	.00170	16.50	35.49	1 inch from end	
20858	T_3 I	57,000	102,400	.00177	17.57	27.87	½ inch from end	
21828	8 R 9 A_4—T_1 O	51,000	94,000	.00140	17.20	38.30	½ inch from end	Accepts 8-inch hoops A_4 Nos. 9 and 10
21830	T_2 M	52,000	97,600	.00160	18.00	29.07	⅝ inch from end	
21829	T_3 I	56,000	106,000	.00177	14.87	15.65	¾ inch from end	
21970	8 R 11 A_4—T_2 M	52,000	97,200	.00160	8.40	13.02	⅝ inch from end	Accepts 8-inch hoops A_4 No. 11 and A_3 No. 11.
21969	T_1 O	56,000	102,800	.00170	17.20	31.43	1½ inches from end	
21955	T_3 I	53,000	97,600	.00167	15.10	24.82	½ inch from end	
21978	T_4 M	52,000	96,000	.00150	16.10	29.66	1 inch from end	

Midvale Steel Works.—Tensile tests for 8-inch B. L. steel rifles—Continued.

TABLE XVIII.—HOOPS A_5.

[Specimens 3 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section. Contract of July 15, 1891.]

Mid-vale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
20334	8 R 1 A_5—T_1 O	54,000	101,240	.00163	18.00	35.78	1¼ inches from end	Accepts 8-inch hoop A_5 No. 1.
20294	T_4 M	50,000	97,200	.00167 .00333	16.50	29.37	1½ inches from end	
20335	T_5 I	51,000	94,000	.00167	21.90	48.44	1¾ inches from end	
20169	8 R 2 A_5—T_1 O	57,000	105,840	.00190	17.43	35.21	1¼ inches from end	Accepts 8-inch hoop A_5 No. 2.
20094	T_2 M	54,000	104,400	.00190	17.40	28.77	¾ inch from end	
20170	T_3 I	55,000	105,600	.00180	15.10	30.55	1¼ inches from end	
20446	8 R 3 A_5—T_1 O	56,000	111,200	.00200	15.50	27.56	1½ inches from end	Accepts 8-inch hoop A_5 No. 3.
20403	T_4 M	50,000	101,200	.00170	15.10	24.82	1 inch from end	
20431	T_5 I	51,000	100,000	.00160	12.90	17.27	1⅜ inches from end	
20464	T_6 I	53,000	100,800	.00177	15.30	24.47	½ inch from end	
20449	8 R 4 A_5—T_1 O	61,000	108,000	.00213	18.23	35.21	1 inch from end	Accepts 8-inch hoop A_5 No. 4.
20412	T_2 M	55,000	104,400	.00170	18.00	31.73	1½ inches from end	
20463	T_3 I	63,000	107,120	.00210	17.30	34.92	1 inch from end	
20791	8 R 5 A_5—T_1 O	55,000	96,400	.00157	19.07	40.52	1¾ inches from end	Accepts 8-inch hoops A_5 Nos. 5 and 6.
20765	T_2 M	51,000	96,000	.00170	17.10	28.17	1¼ inches from end	
20792	T_3 I	56,000	98,000	.00173	17.70	34.05	1⅛ inches from end	
20985	8 R 7 A_5—T_1 O	55,000	94,000	.00177	18.70	36.63	1⅜ inches from end	Accepts 8-inch hoops A_5 Nos. 7 and 8.
20951	T_2 M	53,000	97,600	.00150	20.30	35.21	1¼ inches from end	
20986	T_3 I	53,000	96,400	.00173	15.20	28.77	1⅛ inches from end	
21824	8 R 9 A_5—T_1 O	57,000	102,400	.00210	16.67	27.56	1¼ inches from end	Accepts 8-inch hoops A_5 Nos. 9 and 10.
21827	T_2 M	52,000	96,800	.00173	15.80	24.20	1 inch from end	
21825	T_3 I	58,000	102,000	.00177	13.33	14.01	7/8 inch from end	
21899	8 R 11 A_5—T_1 O	54,000	96,000	.00160	20.00	39.14	1⅝ inches from end	Accepts 8-inch hoop A_5 No. 11.
21976	T_2 M	51,000	94,000	.00140	20.70	38.03	1¼ inches from end	
21993	T_3 I	53,000	93,680	.00160	20.60	34.05	⅝ inch from end	

TABLE XIX.—HOOPS C_1.

18840	8 R 1 C_1—T_1 O	59,000	106,000	.00183	18.20	33.76	$1\frac{3}{8}$ inches from end	Accepts 8-inch hoop C_1 No. 1.
18736	T_3 M	56,000	105,600	.00207	16.53	32.90	1 inch from end	
18839	T_4 I	56,000	103,400	.00190	15.10	32.02	$\frac{3}{8}$ inch from end	
19025	8 R 2 C_1—T_1 O	54,000	95,600	.00177	18.80	38.58	1 inch from end	Accepts 8-inch hoop C_1 No. 2.
18866	T_3 M	52,000	95,600	.00180	22.00	44.02	$1\frac{1}{2}$ inches from end	
19026	T_4 I	51,000	94,800	.00167	18.00	32.02	$1\frac{1}{2}$ inches from end	
18629	8 R 3 C_1—T_1 O	57,000	103,600	.00183	18.20	32.02	$1\frac{1}{2}$ inches from end	Accepts 8-inch hoop C_1 No. 3.
18482	T_2 M	51,000	100,800	.00183	19.00	32.32	$\frac{3}{4}$ inch from end	
18630	T_3 I	56,000	102,400	.00197	17.33	35.78	$1\frac{3}{8}$ inches from end	
18625	8 R 4 C_1—T_1 O	57,000	100,400	.00183	16.20	38.30	$1\frac{5}{8}$ inches from end	Accepts 8-inch hoop C_1 No. 4.
18568	T_2 M	54,000	102,000	.00180	15.10	17.27	$1\frac{3}{8}$ inches from end	
18626	T_3 I	53,000	99,600	.00190	18.50	34.64	$1\frac{1}{2}$ inches from end	
18751	8 R 5 C_1—T_1 O	53,000	97,600	.00177	17.90	35.21	$1\frac{1}{2}$ inches from end	Accepts 8-inch hoop C_1 No. 5.
18696	T_2 M	55,000	99,200	.00177	17.33	32.02	$\frac{5}{8}$ inch from end	
18752	T_3 I	55,000	96,800	.00187	16.67	29.96	$\frac{3}{4}$ inch from end	
18720	8 R 6 C_1—T_1 O	57,000	103,600	.00200	14.10	21.41	$1\frac{1}{2}$ inches from end	Accepts 8-inch hoop C_1 No. 6.
18683	T_2 M	53,000	99,600	.00207	16.60	31.14	$1\frac{1}{2}$ inches from end	
18734	T_3 I	53,000	94,400	.00180	22.50	48.94	$1\frac{1}{2}$ inches from end	
18777	8 R 7 C_1—T_1 O	58,000	99,600	.00210	21.40	41.34	$1\frac{5}{8}$ inches from end	Accepts 8-inch hoop C_1 No. 7.
18709	T_2 M	55,000	102,800	.00183	18.07	35.21	$\frac{3}{4}$ inch from end	
18778	T_3 I	59,000	102,800	.00210	17.00	33.48	$\frac{3}{4}$ inch from end	
18867	8 R 8 C_1—T_1 O	59,000	102,800	.00200	16.30	39.66	$1\frac{3}{8}$ inches from end	Accepts 8-inch hoop C_1 No. 8.
18800	T_2 M	56,000	105,600	.00187	11.90	19.83	1 inch from end	
18868	T_3 I	61,000	105,600	.00220	15.10	23.27	$1\frac{1}{4}$ inches from end	
18858	8 R 9 C_1—T_1 O	52,000	94,400	.00180	17.20	32.61	1 inch from end	Accepts 8-inch hoop C_1 No. 9.
18797	T_2 M	54,000	98,800	.00180	16.70	27.87	1 inch from end	
18859	T_3 I	53,000	93,200	.00173	20.40	43.49	1 inch from end	
18951	8 R 10 C_1—T_1 O	52,000	93,200	.00173	23.60	47.66	1 inch from end	Accepts 8-inch hoop C_1 No. 10.
18832	T_2 M	55,000	96,800	.00180	19.20	37.19	$1\frac{3}{8}$ inches from end	
18952	T_3 I	52,000	92,600	.00180	21.70	39.96	$\frac{3}{4}$ inch from end	
18951	8 R 11 C_1—T_1 O	56,000	98,000	.00183	18.50	40.25	1 inch from end	Accepts 8-inch hoop C_1 No. 11.
18832	T_2 M	53,000	98,000	.00187	17.50	34.34	$\frac{5}{8}$ inch from end	
18952	T_3 I	58,000	99,200	.00203	20.60	43.75	$1\frac{5}{8}$ inches from end	
18972	8 R 12 C_1—T_1 O	54,000	100,000	.00173	18.87	38.30	$1\frac{5}{8}$ inches from end	Accepts 8-inch hoop C_1 No. 12.
18878	T_2 M	54,000	95,200	.00167	18.40	34.05	$1\frac{5}{8}$ inches from end	
18973	T_3 I	55,000	95,600	.00183	18.00	29.37	$1\frac{5}{8}$ inches from end	

Midvale Steel Works.—Tensile tests for 8-inch B. L. steel rifles—Continued.

TABLE XX.—HOOPS C_2.

[Specimens 3 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section. Contract of June 15, 1891.]

Midvale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
18417	8 R 1 C_2—T_1 O	56,000	101,200	.00190	21.90	39.96	1½ inches from end	Accepts 8-inch hoop C_2 No. 1.
18391	T_2 M	54,000	102,000	.00170	19.00	36.91	1¼ inches from end	
18418	T_3 I	56,000	101,200	.00187	16.00	38.58	½ inch from end	
18856	8 R 2 C_2—T_1 O	53,000	94,000	.00170	18.53	44.28	1⅝ inches from end	Accepts 8-inch hoop C_2 No. 2.
18462	T_2 M	51,000	92,400	.00170	21.80	47.66	1½ inches from end	
18857	T_3 I	52,000	92,000	.00173	23.40	52.42	1 inch from end	
18739	8 R 3 C_2—T_1 O	59,000	103,600	.00177	6.70	7.31	¼ inch from end	Accepts 8-inch hoop C_2 No. 3.
18682	T_3 M	55,000	101,200	.00187	15.00	26.66	1½ inches from end	
18740	T_4 I	53,000	96,000	.00173	20.40	47.15	1⅝ inches from end	
18798	T_5 O	58,000	103,200	.00200	14.00	18.55	⅜ inch from end, an extra bar taken in prolongation of T_1 O.	
18547	8 R 4 C_2—T_1 O	54,000	104,000	.00173	15.10	28.77	½ inch from end	Accepts 8-inch hoop C_2 No. 4.
18461	T_2 M	53,000	104,400	.00177	16.80	27.26	1½ inches from end	
18548	T_3 I	60,000	108,800	.00197	15.50	32.32	½ inch from end	
18656	8 R 5 C_2—T_1 O	55,000	102,400	.00173	18.70	35.21	1⅝ inches from end	Accepts 8-inch hoop C_2 No. 5.
18455	T_2 M	56,000	104,000	.00183	19.00	30.55	1 inch from end	
18650	T_3 I	56,000	102,800	.00193	20.30	38.30	1 inch from end	
18549	8 R 6 C_2—T_1 O	54,000	100,000	.00173	17.23	23.58	¾ inch from end	Accepts 8 inch hoop C_2 No. 6.
18459	T_2 M	50,000	94,800	.00173	17.73	30.85	1¼ inches from end	
18550	T_3 I	53,000	92,800	.00163	24.00	47.40	1⅝ inches from end	
19041	8 R 7 C_2—T_1 O	57,000	101,600	.00183	15.00	25.43	¾ inch from end	Accepts 8-inch hoop C_2 No. 7.
18893	T_3 M	50,000	93,600	.00173	18.90	36.06	1¼ inches from end	
19042	T_4 I	51,000	92,000	.00163	22.10	45.86	1⅛ inches from end	
19298	8 R 8 C_2—T_1 O	56,000	102,000	.00177	20.60	41.61	1⅝ inches from end	Accepts 8-inch hoop C_2 No. 8.
19182	T_4 M	52,000	103,200	.00170	18.53	37.19	1⅝ inches from end	
19299	T_5 I	60,000	102,400	.00200	17.60	38.03	⅝ inch from end	
19058	8 R 9 C_2—T_1 O	62,000	105,600	.00207	16.40	31.43	1 inch from end	Accepts 8-inch hoop C_2 No. 9.
18985	T_3 M	54,000	104,800	.00190	15.60	23.58	1⅛ inches from end	
19066	T_4 I	55,000	105,600	.00187	15.20	26.96	1½ inches from end	
19186	8 R 10 C_2—T_1 O	58,000	104,800	.00200	18.00	34.34	1¼ inches from end	Accepts 8-inch hoop C_2 No. 10.
19131	T_3 M	54,000	102,800	.00177	16.20	34.05	1¼ inches from end	
19208	T_4 I	54,000	98,800	.00187	19.37	45.86	1⅛ inches from end	
18894	8 R 11 C_2—T_1 O	58,000	106,800	.00203	15.20	20.77	1 inch from end	Accepts 8-inch hoop C_2 No. 11.
18795	T_2 M	52,000	104,800	.00177	14.60	22.34	¾ inch from end	
18895	T_3 I	59,000	105,600	.00190	15.30	24.51	1⅛ inches from end	
18953	8 R 12 C_2—T_1 O	55,000	101,200	.00193	16.00	22.65	1⅝ inches from end	Accepts 8-inch hoop C_2 No. 12.
18801	T_2 M	54,000	100,000	.00173	15.70	31.43	½ inch from end	
18954	T_3 I	52,000	99,200	.00180	17.40	38.30	¾ inch from end	

TABLE XXI.—HOOPS C_3.

18410	8 R 1 C_3—T_1 O	55,000	99,200	.00170	20.20	39.14	$1\frac{6}{8}$ inches from end	Accepts 8-inch hoop C_3 No. 1.
18390	T_2 M	51,000	98,400	.00173	16.70	36.91	$\frac{6}{8}$ inch from end	
18411	T_3 I	60,000	100,000	.00173	20.50	44.81	$1\frac{5}{8}$ inches from end	
18444	8 R 2 C_3—T_1 O	56,000	100,800	.00193	20.00	38.58	$1\frac{1}{4}$ inches from end	Accepts 8-inch hoop C_3 No. 2.
18393	T_2 M	54,000	103,200	.00177	17.17	28.47	$1\frac{1}{8}$ inches from end	
18458	T_3 I	53,000	98,800	.00177	21.60	39.41	$1\frac{1}{8}$ inches from end	
18536	8 R 3 C_3—T_1 O	55,000	102,000	.00180	18.00	33.76	1 inch from end	Accepts 8-inch hoop C_3 No. 3.
18409	T_2 M	54,000	101,600	.00157	20.80	34.34	$1\frac{1}{4}$ inches from end	
18535	T_3 I	54,000	101,200	.00173	18.73	33.48	1 inch from end	
18520	8 R 4 C_3—T_1 O	52,000	93,600	.00163	18.80	44.28	$\frac{3}{4}$ inch from end	Accepts 8-inch hoop C_3 No. 4.
18420	T_2 M	55,000	101,600	.00157	18.60	30.25	$1\frac{3}{8}$ inches from end	
18522	T_3 I	54,000	98,000	.00177	18.40	34.05	1 inch from end	
18957	8 R 5 C_3—T_1 O	55,000	100,800	.00203	15.70	28.47	$1\frac{1}{8}$ inches from end	Accepts 8-inch hoop C_3 No. 5.
18877	T_3 M	54,000	99,200	.00180	16.80	26.66	$\frac{3}{4}$ inch from end	
18958	T_4 I	56,000	98,800	.00197	13.40	18.23	$1\frac{3}{8}$ inches from end	
18617	8 R 6 C_3—T_1 O	55,000	100,000	.00180	19.80	34.64	$1\frac{1}{4}$ inches from end	Accepts 8-inch hoop C_3 No. 6.
18443	T_2 M	52,000	101,200	.00180	16.60	25.43	$1\frac{1}{8}$ inches from end	
18618	T_3 I	57,000	102,400	.00180	18.77	39.69	$\frac{7}{8}$ inch from end	
18493	8 R 7 C_3—T_1 O	53,000	100,400	.00180	19.10	35.49	1 inch from end	Accepts 8-inch hoop C_3 No. 7.
18442	T_2 M	52,000	101,600	.00180	19.30	30.25	1 inch from end	
18494	T_3 I	56,000	102,800	.00180	19.50	37.47	1 inch from end	
18521	8 R 8 C_3—T_1 O	57,000	102,000	.00180	20.00	36.63	$1\frac{1}{2}$ inches from end	Accepts 8-inch hoop C_3 No. 8.
18460	T_2 M	51,000	100,400	.00157	18.80	26.35	1 inch from end	
18526	T_3 I	54,000	98,000	.00170	17.47	39.96	$1\frac{5}{8}$ inches from end	
18869	8 R 9 C_3—T_1 O	54,000	102,000	.00177	16.30	33.48	$\frac{5}{8}$ inch from end	Accepts 8-inch hoop C_3 No. 9.
18796	T_3 M	56,000	104,000	.00200	15.00	28.47	1 inch from end	
18879	T_4 I	56,000	102,800	.00167	18.00	33.19	$\frac{6}{8}$ inch from end	
18558	8 R 10 C_3—T_1 O	59,000	102,400	.00207	17.43	37.75	$\frac{5}{8}$ inch from end	Accepts 8-inch hoop C_3 No. 10.
18481	T_2 M	52,000	96,400	.00163	16.00	30.55	$1\frac{1}{4}$ inches from end	
18559	T_3 I	50,000	94,800	.00163	16.30	27.56	$\frac{7}{8}$ inch from end	
19138	8 R 11 C_3—T_4 O	55,000	100,000	.00180	17.23	41.34	$1\frac{1}{8}$ inches from end	Accepts 8-inch hoop C_3 No. 11.
19065	T_5 M	53,000	99,200	.00180	19.30	30.85	$\frac{3}{4}$ inch from end	
19139	T_6 I	54,000	98,000	.00167	18.10	44.81	$1\frac{3}{8}$ inches from end	
19362	8 R 12 C_3—T_1 O	54,000	99,600	.00173	15.30	27.87	1 inch from end	Accepts 8-inch hoop C_3 No. 12.
19181	T_4 M	55,000	102,800	.00200	15.00	31.14	1 inch from end	
19385	T_5 I	53,000	92,800	.00180	21.00	43.22	$1\frac{1}{8}$ inches from end	

Midvale Steel Works.—Tensile tests for 8-inch B. L. steel rifles—Continued.

TABLE XXII.—HOOPS C_4.

[Specimens 3 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section. Contract of June 15, 1891.]

Midvale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
18775	8 R 1 C_4—T_1 O	55,000	103,200	.00177	19.40	38.58	1¼ inches from end	Accepts 8-inch hoop C_4 No. 1.
18722	T_3 M	53,000	102,000	.00173	15.50	33.19	1⅝ inches from end	
18776	T_4 I	56,000	100,400	.00193	17.57	38.86	⅝ inch from end	
19763	8 R 2 C_4—T_1 O	61,000	106,800	.00200	15.20	35.21	1⅛ inches from end	Accepts 8-inch hoop C_4 No. 2.
19699	T_5 M	54,000	100,800	.00167	16.67	34.05	1¼ inches from end	
19764	T_6 I	50,000	99,600	.00167	17.40	32.90	1½ inches from end	
18671	8 R 3 C_4—T_1 O	53,000	102,400	.00180	19.10	34.34	1 inch from end	Accepts 8-inch hoop C_4 No. 3.
18503	T_2 M	54,000	103,200	.00190	19.10	30.55	1⅛ inches from end	
18672	T_3 I	59,000	102,000	.00193	18.40	42.42	1¼ inches from end	
18658	8 R 4 C_4—T_1 O	53,000	104,000	.00173	18.00	32.61	1½ inches from end	Accepts 8-inch hoop C_4 No. 4.
18594	T_2 M	55,000	104,400	.00170	20.00	27.26	1 inch from end	
18649	T_3 I	57,000	103,200	.00193	16.50	39.14	1 inch from end	
18705	8 R 5 C_4—T_1 O	60,000	106,400	.00200	18.33	37.47	1 inch from end	Accepts 8-inch hoop C_4 No. 5.
18659	T_2 M	57,000	109,600	.00193	19.70	34.92	1⅝ inches from end	
18699	T_3 I	63,000	110,800	.00210	15.00	29.96	⅝ inch from end	
19188	8 R 6 C_4—T_1 O	55,000	102,800	.00173	18.50	30.85	1⅜ inches from end	Accepts 8-inch hoop C_4 No. 6.
19102	T_3 M	55,000	104,000	.00177	16.70	34.64	1¼ inches from end	
19185	T_4 I	53,000	99,200	.00177	19.07	39.14	1 inch from end	
18685	8 R 7 C_4—T_1 O	61,000	108,000	.00210	16.80	35.21	1 inch from end	Accepts 8-inch hoop C_4 No. 7.
18598	T_2 M	53,000	107,200	.00173	15.70	27.56	1 inch from end	
18687	T_3 I	61,000	108,400	.00213	18.27	35.21	⅞ inch from end	
18794	8 R 8 C_4—T_1 O	57,000	108,000	.00180	14.00	30.55	1 inch from end	Accepts 8-inch hoop C_4 No. 8.
18706	T_2 M	54,000	105,200	.00206	16.00	28.17	¾ inch from end	
18782	T_3 I	62,000	110,520	.00213	15.00	29.37	1 inch from end	
18716	8 R 9 C_4—T_1 O	57,000	104,560	.00183	16.50	33.76	1⅛ inches from end	Accepts 8-inch hoop C_4 No. 9.
18684	T_2 M	53,000	100,800	.00170	17.60	36.34	⅝ inch from end	
18719	T_3 I	57,000	102,800	.00193	17.47	30.85	½ inch from end	
19132	8 R 10 C_4—T_1 O	52,000	99,200	.00180	17.33	33.76	1 inch from end	Accepts 8-inch hoop C_4 No. 10.
19057	T_3 M	50,000	99,600	.00160	16.20	35.78	1½ inches from end	
19134	T_4 I	57,000	103,400	.00200	17.70	24.51	1¼ inches from end	
18733	8 R 11 C_4—T_1 O	55,000	96,400	.00187	17.43	40.25	1⅛ inches from end	Accepts 8-inch hoop C_4 No. 11.
18686	T_2 M	53,000	98,000	.00113	17.90	39.41	½ inch from end	
18743	T_3 I	57,000	98,000	.00190	16.83	25.74	1 inch from end	
18955	8 R 12 C_4—T_1 O	54,000	99,600	.00173	17.20	36.63	⅝ inch from end	Accepts 8-inch hoop C_4 No. 12.
18896	T_2 M	52,000	98,400	.00167	16.30	24.51	¾ inch from end	
18956	T_3 I	53,000	102,000	.00180	15.00	33.19	½ inch from end	

TABLE XXIII.—HOOPS C_5.

18438	8 R 1 C_5—T_1 O	55,000	104,800	.00170	17.63	27.56	1¾ inches from end	Accepts 8-inch hoop C_5 No. 1.
18398	T_2 M	54,000	106,400	.00180	16.00	26.35	1⅛ inches from end	
18439	T_3 I	52,000	104,000	.00180	15.40	28.17	½ inch from end	
18533	8 R 2 C_5—T_1 O	54,000	100,400	.00160	18.40	43.22	¾ inch from end	Accepts 8-inch hoop C_5 No. 2.
18412	T_2 M	55,000	102,800	.00173	17.50	34.05	1 inch from end	
18534	T_3 I	57,000	98,000	.00173	18.21	45.60	1 inch from end	
18688	8 R 3 C_5—T_1 O	55,000	103,200	.00177	18.30	35.78	1⅛ inches from end	Accepts 8-inch hoop C_5 No. 3.
18472	T_2 M	57,000	108,400	.00173	17.20	29.37	1⅛ inches from end	
18689	T_3 I	60,000	106,800	.00217	14.00	30.25	⅝ inch from end	
18670	8 R 4 C_5—T_1 O	54,000	100,400	.00180	19.00	36.06	¾ inch from end	Accepts 8-inch hoop C_5 No. 4.
18562	T_2 M	54,000	99,600	.00180	18.40	34.05	1 inch from end	
18679	T_3 I	56,000	100,400	.00193	15.20	20.45	¼ inch from end	
18647	8 R 5 C_5—T_1 O	53,000	99,200	.00170	20.70	38.03	1½ inches from end	Accepts 8-inch hoop C_5 No. 5.
18575	T_2 M	56,000	101,000	.00170	18.00	41.88	1½ inches from end	
18648	T_3 I	54,000	98,000	.00177	18.90	38.58	¾ inch from end	
18627	8 R 6 C_5—T_1 O	56,000	103,200	.00187	18.80	36.91	1¼ inches from end	Accepts 8-inch hoop C_5 No. 6.
18593	T_2 M	51,000	100,800	.00170	17.47	35.21	1⅛ inches from end	
18628	T_3 I	54,000	104,800	.00167	17.33	32.32	1 inch from end	
18657	8 R 7 C_5—T_1 O	58,000	106,400	.00177	17.93	36.06	¾ inch from end	Accepts 8-inch hoop C_5 No. 7.
18615	T_2 M	55,000	107,600	.00180	19.70	32.32	1⅛ inches from end	
18658	T_3 I	56,000	107,600	.00200	17.00	32.32	⅞ inch from end	
18982	8 R 8 C_5—T_4 O	52,000	100,400	.00167	17.10	31.73	1 inch from end	Accepts 8-inch hoop C_5 No. 8.
18808	T_5 M	53,000	100,000	.00173	15.60	31.43	1 inch from end	
18986	T_6 I	53,000	97,200	.00173	19.50	41.88	1 inch from end	
18766	8 R 9 C_5—T_1 O	55,000	100,600	.00180	15.50	24.82	½ inch from end	Accepts 8-inch hoop C_5 No. 9.
18697	T_2 M	53,000	100,800	.00180	17.73	32.61	¾ inch from end	
18765	T_3 I	53,000	100,000	.00173	16.20	30.55	1 inch from end	
18738	8 R 10 C_5—T_1 O	56,000	98,000	.00203	17.00	26.66	1½ inches from end	Accepts 8-inch hoop C_5 No. 10.
18701	T_2 M	53,000	98,000	.00177	16.20	34.64	¾ inch from end	
18735	T_3 I	52,000	96,400	.00180	18.10	29.96	1 inch from end	
18741	8 R 11 C_5—T_1 O	55,000	103,200	.00180	17.37	31.14	1⅛ inches from end	Accepts 8-inch hoop C_5 No. 11.
18698	T_2 M	54,000	103,200	.00170	19.40	37.47	1 inch from end	
18742	T_3 I	61,000	104,400	.00220	18.00	40.25	1 inch from end	
19594	8 R 12 C_5—T_1 O	61,000	108,400	.00197	14.00	29.96	1 inch from end	Accepts 8-inch hoop C_5 No. 12.
19530	T_3 M	52,000	101,000	.00167	16.73	34.34	1⅛ inches from end	
19595	T_4 I	51,000	99,680	.00167	15.73	30.25	1 inch from end	

Midvale Steel Works.—Tensile tests for 8-inch B. L. steel rifles—Continued.

TABLE XXIV.—HOOPS D_1.

[Specimens 3 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section. Contract of June 15, 1891.]

Midvale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
19883	8 R 1 D_1—T_1 O	50,000	94,400	.00160	20.60	37.19	1½ inches from end	Accepts hoop D_1 No. 1.
19789	T_2 M	53,000	99,000	.00173	17.00	31.43	1⅝ inches from end	
19882	T_3 I	51,000	96,400	.00177	17.60	36.06	1 inch from end	
20279	8 R 2 D_1—T_1 O	55,000	102,400	.00157	15.80	29.96	1 inch from end	Accepts hoop D_1 No. 2.
20239	T_3 M	51,000	100,400	.00197	16.80	35.78	1 inch from end	
20280	T_4 I	54,000	99,600	.00170	19.00	44.81	1 inch from end	
20291	8 R 3 D_1—T_1 O	59,000	107,200	.00197	15.90	19.51	1 inch from end	Accepts hoop D_1 No. 3.
20238	T_2 M	53,000	101,200	.00177	17.00	31.14	¾ inch from end	
20288	T_3 I	55,000	102,800	.00177	15.30	36.35	¾ inch from end	
20512	8 R 4 D—T_1 O	62,000	110,280	.00210	17.53	30.25	1¼ inches from end	Accepts hoop D_1 No. 4.
20469	T_2 M	54,000	104,800	.00167	19.00	34.64	1½ inches from end	
20523	T_3 I	59,000	104,400	.00187	16.60	32.32	1 inch from end	
20991	8 R 5 D_1—T_1 O	56,000	97,600	.00167	15.30	24.20	⅝ inch from end	Accepts hoops D_1 Nos. 5 and 6.
20959	T_2 M	50,000	93,600	.00173	15.00	19.51	1½ inches from end	
21001	T_3 I	54,000	96,000	.00170	15.10	27.87	⅝ inch from end	
21048	8 R 7 D_1—T_1 O	54,000	94,400	.00147	21.50	49.96	1 inch from end	Accepts hoops D_1 No. 7.
21026	T_2 M	51,000	96,000	.00157	10.60	14.01	⅛ inch from end	
21069	T_3 I	55,000	96,000	.00167	14.10	24.20	⅛ inch from end	
21094	T_4 M	52,000	95,400	.00153	20.00	32.61	1½ inches from end	Accepts hoops D_1 Nos. 8 and 9.
21145	8 R 9 D_1—T_1 O	57,000	100,000	.00180	17.60	37.47	1 inch from end	
21070	T_2 M	56,000	100,800	.00163	14.40	23.58	1⅛ inches from end	
21146	T_3 I	54,000	96,000	.00150	15.13	36.35	¾ inch from end	
21806	8 R 10 D_1—T_1 O	55,000	96,000	.00200	17.66	27.56	1⅜ inches from end	Accepts hoop D_1 No. 10.
21804	T_2 M	55,000	102,000	.00173	17.93	28.17	1⅛ inches from end	
21805	T_3 I	51,000	95,200	.00180	17.26	36.63	1 inch from end	
21991	8 R 12 D_1—T_1 O	56,000	95,200	.00167	21.40	46.89	1⅛ inches from end	Accepts hoops D_1 Nos. 11 and 12.
21990	T_2 M	53,000	94,240	.00160	18.30	32.32	⅞ inch from end	
21968	T_3 I	53,000	99,600	.00153	16.60	27.56	1 inch from end	

TABLE XXV.—HOOPS D_2.

20016	8 R 1 D_2—T_1 O	52,000	103,200	.00177	17.33	22.96	1¼ inches from end	Accepts hoop D_2 No. 1.
20027	T_2 M	56,000	106,800	.00183	15.00	22.34	1½ inches from end	
20009	T_3 I	70,000	110,000	.00210	16.60	37.19	⅝ inch from end	
20386	8 R 2 D_2—T_1 O	56,000	103,200	.00177	18.60	41.61	1¼ inches from end	Accepts hoop D_2 No. 2.
20360	T_3 M	56,000	106,000	.00180	17.50	36.34	1⅜ inches from end	
20387	T_4 I	55,000	104,800	.00193	19.40	35.49	1½ inches from end	
20509	8 R 3 D_2—T_1 O	50,000	97,200	.00143 to .00177	20.40	40.25	1½ inches from end	Accepts hoop D_2 No. 3.
20468	T_2 M	54,000	100,800	.00180	16.50	24.82	1⅜ inches from end	
20508	T_3 I	52,000	98,800	.00160	20.00	38.15	1⅝ inches from end	
20521	8 R 4 D_2—T_1 O	57,000	100,800	.00163	20.40	43.49	1½ inches from end	Accepts hoop D_2 No. 4.
20492	T_2 M	55,000	104,000	.00187	19.80	34.64	1 inch from end	
20522	T_3 I	53,000	96,000	.00150	21.70	42.42	1¼ inches from end	
21005	8 R 5 D_2—T_1 O	56,000	98,800	.00177	17.00	25.74	1⅜ inches from end	Accepts hoops D_2 Nos. 5 and 6.
20974	T_2 M	55,000	98,000	.00163	15.30	29.66	⅞ inch from end	
21006	T_3 I	56,000	98,000	.00193	16.80	26.35	¾ inch from end	
21032	8 R 7 D_2—T_1 O	60,000	106,400	.00183	17.20	35.49	1½ inches from end	Accepts hoops D_2 Nos. 7 and 8.
21002	T_2 M	58,000	106,000	.00177	18.20	33.48	1¼ inches from end	
21029	T_3 I	61,000	108,000	.00200	16.40	34.92	1⅜ inches from end	
21831	8 R 9 D_2—T_1 O	57,000	98,000	.00173	20.03	41.88	¾ inch from end	Accepts hoops D_2 Nos. 9 and 10.
21809	T_2 M	56,000	102,800	.00180	14.17	20.77	1½ inches from end	
21826	T_3 I	62,000	102,400	.00200	15.20	21.41	⅝ inch from end	
21961	8 R 12 D_2—T_1 O	55,000	98,000	.00170	20.40	36.91	1⅛ inches from end	Accepts hoops D_2 Nos. 11 and 12.
21943	T_2 M	51,000	97,800	.00147	17.80	31.73	1⅝ inches from end	
21962	T_3 I	46,000	96,000	.00180	21.21	42.95	1 inch from end	

Midvale Steel Works.—Tensile tests for 8-inch B. L. steel rifles—Continued.

TABLE XXVI.—BREECH BUSHING RINGS.

[Specimens 2 inches long between shoulders, diameter 0.505 inch, and 0.20 square inch cross section. Contract of June 15, 1891.]

Mid. vale No.	Marks on specimens.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch under stress at elastic limit.	Ultimate elongation after rupture, per cent of original length.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
		Pounds.	*Pounds.*					
18556	8 R 1 B B R—T_1 O	59,000	103,500	.00190	21.00	35.05	$\frac{7}{16}$ inch from end	Accepts breech bushing rings Nos. 1 and 3.
18507	T_2 M	55,000	102,050	.00170	18.10	24.76	$\frac{7}{16}$ inch from end	
18799	8 R 2 B B R—T_1 O	57,000	100,000	.00185	23.80	39.14	$\frac{3}{4}$ inch from end	Accepts breech bushing rings Nos. 2 and 4.
18707	T_2 M	55,000	98,000	.00180	19.80	35.21	1 inch from end	
18763	8 R 5 B B R—T_1 O	57,000	99,500	.00190	22.50	40.99	$\frac{5}{8}$ inch from end	Accepts breech bushing rings Nos. 5 and 6.
18724	T_2 M	55,000	100,500	.00175	22.20	36.64	1 inch from end	
19384	8 R 9 B B R—T_3 O	54,000	97,500	.00170	22.50	39.14	1 inch from end	Accepts breech bushing rings Nos. 9 and 10.
19187	T_4 M	50,000	95,000	.00150	20.60	30.15	1 inch from end	
19960	8 R 7 B B R—T_6 M	54,000	103,000	.00165	18.00	32.15	$\frac{3}{4}$ inch from end	Accepts breech bushing ring No. 7.
19959	T_7 O	57,000	95,500	.00170	21.00	38.84	$\frac{5}{8}$ inch from end	
21396	8 R 8 B B R—T_1 O	58,000	103,000	.00170	22.50	45.73	1 inch from end	Accepts breech bushing rings Nos. 8, 11, and 12.
21377	T_2 M	54,000	100,500	.00155	22.00	37.59	1 inch from end	

TABLE XXVII.—BREECH MECHANISM.

[Specimens 3 inches long between shoulders, diameter 0.564 inch, and 0.25 square inch cross section. Contract of June 15, 1891.]

	(*a*) *Breechblocks.*							
18322	8 R 1 B B—T_1 M	49,000	92,400	.00160	18.93	36.06	1 inch from end	Accepts breechblocks Nos. 1 and 2.
18323	8 R 3 B B—T_1 M	49,000	93,200	.00157	18.37	26.05	1 inch from end	Accepts breechblocks Nos. 3 and 4.
18416	8 R 5 B B—T_1 M	49,000	93,200	.00167	18.83	31.73	$1\frac{3}{8}$ inches from end	Accepts breechblocks Nos. 5 and 6.
18419	8 R 7 B B—T_1 M	53,000	102,000	.00187	17.10	28.77	$1\frac{1}{4}$ inches from end	Accepts breechblocks Nos. 7 and 8.
18415	8 R 9 B B—T_1 M	52,000	97,600	.00163	19.33	32.32	$1\frac{3}{8}$ inches from end	Accepts breechblocks Nos. 9 and 10.
18413	8 R 12 B B—T_1 M	47,000	90,800	.00143	17.00	41.34	$\frac{3}{4}$ inch from end	Accepts breechblocks Nos. 11 and 12.
	(*b*) *Spindles.*							
16994	8 R 1 S P—T_1 O	55,000	99,500	.00165	19.20	31.80	$1\frac{1}{8}$ inches from end	Accepts spindles Nos. 1 and 2.
17059	8 R 5 S P—T_1 O	51,000	90,500	.00155	17.00	20.62	$\frac{3}{4}$ inch from end	Accepts spindles Nos. 5 and 6.
17082	8 R 7 S P—T_1 O	54,000	93,500	.00160	23.10	46.88	$1\frac{1}{8}$ inches from end	Accepts spindles Nos. 7 and 8.
18953	8 R 9 S P—T_3 O	47,000	87,000	.00150	22.60	39.74	$\frac{1}{8}$ inch from end	Accepts spindles Nos. 9 and 10.
17083	8 R 12 S P—T_1 O	52,000	93,000	.00160	21.80	40.99	1 inch from end	Accepts spindles Nos. 11 and 12.
19163	8 R 14 S P—T_1 O	53,000	94,000	.00170	24.60	49.47	$1\frac{1}{8}$ inches from end	Accepts spindle No. 14.
21729	8 R 15 S P—T_1 O	53,000	91,000	.00160	24.20	46.63	$\frac{3}{4}$ inch from end	Accepts spindle No. 15.

	(e) Front gas-check cups.							
17821	8 R 1 F G C—T_1 O	75,000	128,080	.00250	16.80	37.19	1½ inches from end	Accepts front gas checks Nos. 1, 2, 3, and 4.
17942	T_2 M	75,000	129,200	.00203	17.33	36.91	1⅛ inches from end	
17779	8 R 5 F G C—T_1 O	78,000	128,800	.00253	15.40	39.96	1¼ inches from end	Accepts front gas checks Nos. 5, 6, 7, and 8.
17819	T_2 M	75,000	129,200	.00243	16.00	38.30	1½ inches from end	
17822	8 R 12 F G C—T_1 O	76,000	128,400	.00250	17.00	44.28	1 inch from end	Accepts front gas checks Nos. 9, 10, 11, and 12.
17943	T_2 M	71,000	126,000	.00243	16.40	44.02	1 inch from end	
	(d) Rear gas-check cups.							
17820	8 R 1 R G C—T_1 O	76,000	127,200	.00223	16.00	41.61	1½ inches from end	Accepts rear gas checks Nos. 1, 2, 3, and 4.
17945	T_2 M	74,000	127,200	.00240	15.70	39.41	¾ inch from end	
17805	8 R 5 R G C—T_1 O	77,000	132,800	.00247	15.90	38.30	1⅜ inches from end	Accepts rear gas checks Nos. 5, 6, 7, and 8.
17944	T_2 M	75,000	128,040	.00240	14.30	37.19	¾ inch from end	
17806	8 R 12 R G C—T_1 O	76,000	128,000	.00250	15.20	44,81	1⅝ inches from end	Accepts rear gas checks Nos. 9, 10, 11, and 12.
17956	T_2 M	71,000	126,000	.00180	16.30	42.15	1½ inches from end	
	(e) Securing pin bars.							
19209	8 R 1 S P B—L_1 A	82,000	130,040	.00270	17.33	48.70	1½ inches from end	Accepts securing pin bars Nos. 1 to 12.
19258	L_1 B	82,000	132,160	.00287	17.07	45.86	1 inch from end	
19259	L_1 C	82,000	130,000	.00273	18.20	50.96	1¼ inches from end	
	(f) 8-inch breech plates (steel castings).							
20493	8 R 5 B P—T_1 O	36,400	85,600	.....	16.70	27.56	Specimen, 3 inches	Accepts 8-inch breech plates Nos. 5, 6, and 7.
20878	8 B P—T_1 M	44,720	90,880	.....	12.00	13.35	Specimen, 3 inches	Accepts 8-inch breech plates Nos. 8, 9, and 10.
20918	8 B P—T_2 M	43,500	90,000	.....	12.70	17.77	Specimen, 2 inches	
20935	11 B P—T_1 M	50,000	93,600	.....	11.00	13.68	Specimen, 3 inches	Accepts 8-inch breech plates Nos. 11, 12, and 13.
21052	11 B P—T_2 M	49,000	94,000	.....	12.00	15.23	Specimen, 2 inches	
21304	14 B P—T_1 M	34,800	80,400	.....	23.00	30.55	Specimen, 3 inches	Accepts 8-inch breech plates Nos. 14, 15, and 16.

Midvale Steel Works.—Tensile tests for 8-inch disappearing carriage (ordered by Southwark Foundry and Machine Company).

TABLE XXVIII.—STEEL FORGINGS.

[Specimens 2 inches long between shoulders, diameter 0.505 inch, and 0.20 square inch cross section.]

Midvale No.	Marks on specimens.	Midvale forging No.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch after rupture.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
			Pounds.	*Pounds.*				
Not given.	8 C 1 P R—L_1 M	S—5801	55,500	94,500	27.50	49.72		Accepts piston rod Nos. 1 and 2; elevated rods Nos. 1 and 2.
21270	8 C 1 R—T_1 M	S—5802	50,000	102,500	17.40	21.32		Accepts 11 rollers Nos. 1 to 11.
21275	8 C 22 R—T_1 M	S—5803	51,000	100,000	11.00	11.53		Accepts 11 rollers Nos. 12 to 22.
21303	T_2 O	S—5803	50,000	94,000	8.70	11.53	Second bar, axes 45° with that of T_1 M.	
21262	8 C 1 C R—L_1 M	S—5804	49,000	99,500	18.00	29.15		Accepts 18 conical rollers Nos. 1 to 18.
21302	T_1 M	S—5804	45,000	94,500	17.50	35.70		
21272	8 C 1 S N R—L_1 M	S—5822	50,000	77,000	28.00	60.61		Accepts suspension rod No. 1.
Not given.	8 C 2 S N R—L_1 M	S—5823	46.000	77,600	31.85	60.11		Accepts suspension rod No. 2.
21263	8 C 1 C S H—L_1 M	S—5895	41,500	75,000	31.00	62.31		Accepts countershaft Nos. 1 and 2 and traversing shaft. The latter afterwards condemned for piping.
21338	8 C 1 R A Ax—L_1 C	S—6763	45,000	95,500	22.00	32.15		Accepts rotating arm axle No. 1 and traversing shaft No. 1 to replace "piped" shaft.
21337	L_1 R	S—6763	42,000	91,000	23.00	36.94		
21271	8 C 1 S R S—L_1 M	S—5811	53,500	99,000	22.50	42.18		Accepts suspension rod shaft and 4 caps.
21264	8 C 1 Ax—L_1 M	S—5896	44,500	75,000	33.50	60.86		Accepts 4 axles, 4 axle collars, 4 piston rod nuts.
21265	8 C 1 R Ax—L_1 M	S—5825	42,500	75,100	35.60	68.45		Accepts 1 shaft, 22 roller axles, 2 chain pulleys, 2 chain pulley axles, 1 worm wheel, and 1 elevating shaft.
21923	8 C 1 E R—L_1 M	S—7210	38,500	76,250	30.70	55.71		Accepts elevating rack No. 1.
21924	8 C 2 E R—L_1 M	S—7211	39,750	76,500	33.50	59.61		Accepts elevating rack No. 2.

TABLE XXIX—STEEL CASTINGS.

18509	8 C 1 R A—L_1	20343	34500	66500	33.20	52.22		Accepts rotating arm No. 1. Condemned in machining for cavities.
18595	L_2		33500	65000	36.50	54.91		
18600	L_3		34000	66000	32.50	51.12		
18809	8 C 2 R A—L_1	20438	31750	63500	29.00	41.28		Accepts rotating arm No. 2. Condemned in machining for cavities.
18811	L_2		31000	63750	33.10	54.11		
18810	L_3		32000	64000	36.80	53.87		
19510	8 C 1 T R—L_1	20520	29150	35450	3.00	13.00	Broke through sand spot, visible before testing.	
19527	L_1 A		31000	37500	3.30	1.94	Broke through flaw, beyond reference marks.	Accepts transom No. 1 on these and the heat tests.
19511	L_2		30500	64500	35.00	48.03		
19512	T_3 M		31450	52000	32.00	57.56	Broke through flaw, visible through testing, transverse specimen from riser.	
18854	8 C 1 W H B R—T_1 R S	20439	28500	53000	13.50	25.81	From riser, blow-hole and sand in specimen.	
18838	T_2 R S		29500	58000	22.40	26.30	From second riser	Accepts wheel bracket No. 1.
18813	T_3 R M		31500	64300	32.30	51.97	From runner	
18717	8 C 1 T R W H—T_1 M	20368	(*)	58750	32.20	43.38	From riser	Accepts traverse wheel No. 1.
18732	8 C 2 T R W H—T_1 M	20369	27500	62250	32.50	43.38	From riser	Accepts traverse wheel No. 2; afterwards rejected for blow-holes.
18708	8 C 3 T R W H—T_1 M	20370	29750	62000	30.50	39.14	From riser	Accepts traverse wheel No. 3; afterwards rejected for blow-holes.
19487	8 C 4 T R W H—T M	20696	31500	62500	19.20	30.11	From riser	Accepts traverse wheel No. 4.
19486	8 C 5 T R W H—T_1 M	20712	33500	63950	22.40	32.45	From riser	Accepts traverse wheel No. 5.
19488	8 C 6 T R W H—T_1 M	20713	29000	61000	30.50	38.19	From riser	Accepts traverse wheel No. 6.
18667	8 C 1 R A C—L_1	20372	27500	62000	30.70	58.06		Accepts caps for rotating arms Nos. 1 and 2.
18638	8 C 2 R A C—L_1	20373	29500	62000	35.00	57.31		
19228	8 C 1 T R C S—L_1	20521	30500	63500	32.40	50.32		Accepts segment, traverse circle, No. 1.
19229	L_2	20521	32000	63250	29.60	52.52		
19230	8 C 2 T R C S—L_1	20567	36500	68600	29.70	45.13		Accepts segment, traverse circle, No. 2.
19231	L_2	20567	30000	65950	34.20	49.72		
19528	8 C 3 T R C S—L_1	20644	35500	67250	33.70	51.97		Accepts segment, traverse circle, No. 3.
19529	L_2	20644	34000	67000	33.20	50.57		
22028	8 C 3 R A—L_1	22621	38500	70000	30.30	42.48		Accepts rotating arm No. 3.
22029	L_2	22621	36500	69800	30.10	46.33		
22030	L_3	22621	38000	70500	29.00	39.14		
22036	8 C 4 R A—L_1	22622	35500	70000	30.80	49.17		Accepts rotating arm No. 4.
22043	L_2	22622	36000	70250	31.80	47.77		
22024	L_3	22622	37000	71000	30.50	42.78		
20174	8 C 4 T R C S—L_1	20907	37000	69150	28.00	45.13		Accepts traverse circle, segment No. 4.
20176	L_2	20907	32500	68000	29.30	47.77		
21395	8 C 1 C H—L_1	21626	35500	63000	25.00	35.35		Accepts chassis No. 1; afterwards rejected for cracks.
21351	L_2	21626	32500	65000	33.00	51.97		
21378	L_3	21626	31500	64500	32.00	48.92		
22050	8 C 2 C H—L_1	22055	31500	65500	34.20	45.73		Accepts chassis No. 2.
22046	L_2	22055	32500	65000	35.00	54.11		
22047	L_2	22055	33000	65500	34.70	53.32		

* Not defined.

Midvale Steel Works.—Tensile tests for 8-inch disappearing carriage (ordered by Southwark Foundry and Machine Company)—Continued.

TABLE XXIX—STEEL CASTINGS—Continued.

[Specimens 2 inches long between shoulders, diameter 0.505 inch, and 0.20 square inch cross section.]

Midvale No.	Marks on specimens.	Midvale forging No.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch after rupture.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
			Pounds.	*Pounds.*				
22125	8 C 3 C H—L_1	22717	35000	69500	31.60	47.52		Accepts chassis No. 3.
22147	L_2	22717	32000	69500	32.40	49.72		
22148	L_3	22717	30500	69000	29.50	49.72		
21166	8 C 1 U R P—T_1 R S	21438	34000	64500	24.50	30.50	From riser	Accepts upper roller path No. 1.
21071	L_1 R N	21438	33500	70000	22.80	36.00	From runner	
21305	8 C 1 L R P—L_1 O	21720	36500	75000	30.00	49.17		Accepts lower roller path No. 2.
21332	L_2 I	21720	35500	73000	33.20	47.18		
21336	L_3 I	21720	35000	75000	29.40	48.32		
21347	8 C 1 C H—L_1	21804	35000	70000	33.50	50.87		Accepts cross-head No. 1.
21853	8 C 2 C H—L_1	22329	24750	59500	33.55	50.02		Accepts cross-head No. 2.
21393	8 C 1 R G—L_1	21777	35000	71000	32.00	44.58		Accepts rack guide No. 1.
21394	8 C 2 R G—L_2	21778	35000	71250	32.00	49.17		Accepts rack guide No. 2.
21461	8 C 3 R G—L_1	21882	34500	78000	27.00	38.49		Accepts rack guide No. 3.
21462	8 C 4 R G—L_1	21883	34000	75000	28.50	43.68		Accepts rack guide No. 4.
21469	8 C 1 H C R—L_1	21823	44500	102500	15.20	26.17		Accepts hydraulic cylinder No. 1.
21780	8 C 2 H C L—L_1	22229	40000	85500	17.90	20.62		Accepts hydraulic cylinder No. 2.
21781	T_1 M	22229	32000	63250	8.30	13.38	Large hole in specimen, visible before breaking.	
21566	8 C 1 E B—T_1	22012	37500	62500	18.00	32.15		Accepts elevating band No. 1.
21567	T_2	22012	31000	60000	20.20	47.52		
21348	8 C 1 T R B—T_1	21776	35250	68500	20.50	28.16		Accepts elevating band No. 2.
21349	T_2	21776	30500	60500	31.00	41.89		
20053	8 C 1 P B C—L_1	(and 20908) 20909	35000	67500	32.50	49.72		Accepts pivot bearing caps Nos. 1 and 2.
20026	8 C 1 Clip—L_1	20910	28500	51500	10.00	20.22	From sinking head, broke through flaw, visible before testing.	Accepts clips Nos. 1 and 2.
20025	8 C 2 Clip—L_1	20911	30100	63500	25.80	38.84	From sinking head	

Midvale Steel Works.—Tensile tests for 10-inch disappearing carriage (ordered by Southwark Foundry and Machine Company).

TABLE XXX—STEEL FORGINGS.

[Specimens 2 inches long between shoulders, diameter 0.505 inch, and 0.20 square inch cross section.]

Midvale No.	Marks on specimens.	Midvale forging No.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch after rupture.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
			Pounds.	*Pounds.*				
22235	10 C 1 S P S H—L_1 M	S—7636	49,000	95,500	16.30	19.52		Accepts suspension rod shaft.
22233	10 C 1 S N R—L_1	S—7633	45,000	84,500	29.00	51.42		Accepts suspension rod shaft No. 1.
22234	10 C 2 S N R—L_1	S—7635	44,500	85,500	29.60	49.72		Accepts suspension rod shaft No. 2.
22248	10 C 1 R Ax—L_1	S—7651	48,000	83,500	31.40	54.91		Accepts roller axles Nos. 1 to 12 and piston rod nuts Nos. 1 to 4.
22243	10 C 24 R Ax—L_1	S—7652	47,000	81,750	30.30	52.26		Accepts roller axles Nos. 13 to 24.
22237	10 C 1 W W S H—L_1	S—7735	46,500	84,000	30.60	48.92		Accepts worm wheel shaft No. 1 and chain pulley axles Nos. 1 and 2.
22236	10 C 1 E G C S H—L_1	S—7733	46,750	84,250	29.20	53.07		Accepts elevating gear countershaft Nos. 1 and 2, axle collars Nos. 1 to 4, elevating through shaft Nos. 1 and 2.
22232	10 C 2 E G C S H—L_1	S—7734	48,250	85,000	29.80	53.07		
22238	10 C 1 L S H—L_1	S—7807	52,500	82,500	32.50	56.76		Accepts locking shafts Nos. 1 and 2, locking nuts Nos. 1 and 2, locking handles Nos. 1 to 8, traversing worm shaft No. 1, elevating rack stops Nos. 1 and 2, and elevating rack stop pins Nos. 1 and 2.
22239	10 C 1 R T R W Ax—L_1	7866	42,000	82,000	26.60	47.77		Accepts rear traverse wheel axles Nos. 1 to 4, Spanner wrench No. 1, traversing worm No. 1, and chain pulley Nos. 1 and 2.
22250	10 C 1 E R—L_1	S—7657	51,000	102,500	20.80	31.15		Accepts elevating rod No. 1.
22244	10 C 2 E R—L_1	S—7659	44,500	91,500	22.00	41.28		Accepts elevating rod No. 2 and elevating rod caps Nos. 1 to 4.
22265	L_2 M	S—7659	48,000	95,000	21.40	37.59		
22245	10 C 1 P—L_1	S—7661	48,250	94,500	25.60	45.73		Accepts piston and rod Nos. 1 and 2.
22246	10 C 1 T C R—T_1 M	S—7719	50,500	93,500	26.30	36.94		Accepts top carriage rollers Nos. 1 to 12.
22247	10 C 24 T C R—T_1 M	S—7731	49,750	93,500	21.20	34.74		Accepts top carriage rollers Nos. 13 to 24.
22251	10 C 1 C N R—L_1 M	S—7663	51,500	104,000	18.00	24.41		Accepts conical rollers Nos. 1 to 20.
22252	T_1 M	S—7663	49,500	99,000	12.00	12.28		
22361	10 C 1 E R—L_1	S—8365	47,500	92,000	22.50	44.58		Accepts elevating rack No. 1.
22362	10 C 2 E R—L_1	S—8288	38,000	78,500	31.60	53.07		Accepts elevating rack No. 2.
22483	10 C 1 R Ax—L_1 C	S—8657	49,000	98,500	18.00	25.46		Accepts rotating arm axle, No. 1.
22484	1 R Ax—L_1 R	S—8657	43,000	89,500	20.00	26.46		

Midvale Steel Works.—Tensile tests for 10-inch disappearing carriage (ordered by Southwark Foundry and Machine Company)—Continued.

TABLE XXXI.—STEEL CASTINGS.

[Specimens 2 inches long between sboulders, diameter 0.505 inch, and 0.20 square inch cross section.]

Midvale No.	Marks on specimens.	Midvale forging No.	Elastic limit per square inch of original section.	Ultimate strength per square inch of original section.	Elongation per inch after rupture.	Reduction in area after rupture, per cent of original section.	Position of rupture.	Remarks relative to acceptance, rejection, retreatment, etc.
			Pounds.	*Pounds.*				
22130	10 C 1 R P C—T_1	22,929	31,000	70,000	27.00	34.40		Accepts roller patte clips Nos. 1 and 2.
22136	10 C 1 T C—L_1	22,933	45,000	99,000	12.00	15.23		Accepts trunnion cap No. 1.
22137	2 T C—L_1	22,934	44,500	99,500	12.50	10.78		Accepts trunnion cap No. 2.
21944	10 C 1 R A—L_1	22,335	32,500	65,000	37.50	52.87		Accepts rotating arm No 1.
21945	1 R A—L_2	22,335	32,750	65,100	32.60	48.37		
21946	1 R A—L_3	22,335	32,000	64,800	31.80	50.32		
22174	10 C 1 C R H—L_1	23,041	32,500	72,500	31.00	42.78		Accepts cross-head No. 1.
22208	10 C 1 B R T W H—L_1	22,927	30,000	69,500	32.00	46.33		Accepts bracket for rear traverse wheel No. 1; also elevating rod truss No. 1.
22209	1 B R T W H—L_2	22,927	34,500	72,000	31.00	48.03		
22324	10 C 2 C H—L_1M	23,179	31,500	68,500	29.50	42.48		Accepts cross-head No. 2, traverse wheels Nos. 1, 2, 3, and 4, and chain wheel No. 1.
22382	10 C 1 B R—L_1	23,274	27,500	60,000	9.00	19.17	Broke through a flaw visible before testing.	Accepts traverse gear bracket No. 1, two 10-inch spur wheels, two 8-inch spur wheels, and one 8-inch chain pulley. The last three items were afterwards condemned on account of blow-holes.
22394	1 B R—L_2	23,274	31,000	69,500	30.40	50.57		
22363	10 C 1 R G—L_1	23,217	33,000	69,000	33.00	49.47		Accepts rack guides Nos. 1 and 3.
22381	2 R G—L_1	23,218	31,000	69,250	25.30	30.85		Accepts rack guides Nos. 2 and 4.
22364	10 C 1 H C—L_1M	22,858	45,000	95,000	18.30	30.15		Accepts hydraulic cylinder No. 1.
22399	1 H C—L_2M	22,858	43,500	95,500	15.50	28.85		
22398	1 H C—T_1M	22,858	45,000	95,500	13.60	25.16		

Midvale Steel Works.—Tensile tests for 8 and 12-inch barbette carriages (ordered by Watertown Arsenal).

TABLE XXXII.—STEEL CASTINGS.

[Specimens 2 inches long between shoulders, diameter 0.505 inch, and 0.20 square inch cross section.]

	(a) For 8-inch barbette carriage.							
21565	8 C 1 W G—L_1	22,042	29,000	55,000	7.20	11.53	Broke through a blow-hole.	Accepts worm gear, segmental gear, and chain wheel.
21646	8 C 1 S G—L_2	22,043	33,000	65,000	15.00	23.41	Specimen from riser—blow-hole.	
	(b) For 12-inch barbette carriage.							
21936	12 C 1 S L—L_1	22,250	29,000	60,000	36.00	57.31		Accepts 12-inch carriage slide No. 1.
21937	L_2	22,250	30,000	60,500	36.70	58 31		
21922	L_3	22,250	29,500	61,000	37.00	54.91		
22034	12 C 2 S L—L_1	22,428	25,000	50,000	33.50	54.91		Accepts 12-inch carriage slide No. 2.
22035	L_2	22,428	28,500	59,000	32.20	45.73		
22051	L_3	22,428	27,000	58,700	37.10	55.21		
22138	12 C 1 C—L_1	22,859	31,500	71,000	31.00	48.03		Accepts cylinder gland No. 1, cap No. 1, and cylinder head No. 1.
22129	12 C 2 C—L_1	22,860	30,500	69,500	26.40	34.09		Accepts cylinder gland No. 2, cap No. 2, and cylinder head No. 2.
22126	12 C 1 B E S—L_1	22,865	49,500	97,500	16.80	19.52		Accepts bearing for elevating shaft.
22127	12 C 1 B T W—L_1	22,866	45,500	96,500	15.10	16.32		Accepts bearing for traversing worm.

APPENDIX 36.

PROGRESS REPORT OF MANUFACTURE OF MORTARS AND MORTAR CARRIAGES AT THE BUILDERS' IRON FOUNDRY, PROVIDENCE, R. I.

(7 plates.)

OFFICE OF INSPECTOR OF ORDNANCE, U. S. ARMY,
NO. 22 CODDING STREET,
Providence, R. I., October 13, 1892.

SIR: I have the honor to submit the following report of the construction of 12-inch B. L. rifled mortars, cast iron, steel hooped, and spring return carriages for the same, at the Builders' Iron Foundry, during the fiscal year ended June 30. 1892:

Thirty cast-iron mortar bodies were procured from this foundry under contract of January 8, 1889, of which seven had been used in the construction of mortars during the fiscal year ended June 30, 1891, leaving twenty-three on hand.

By their contract of August 19, 1889, the Builders' Iron Foundry agreed to finish and assemble these mortars for $3,725 each, the steel forgings, such as A and B hoops, breechblocks, spindles, face plates, gas-check cups, hinge pins, translating rollers, and pinions for rotating breechblocks, to be furnished by the United States. All these forgings were purchased under contract from the Midvale Steel Company of Pennsylvania.

In addition, by contract of November 24, 1890, with the South Boston Iron Works, forty-three cast-iron mortar bodies were to be furnished the United States at $1,850 each, and by additional contract of November 25, 1890, the same company agreed to finish and assemble the mortars at $3,550 each. The later work having been transferred to the Builders' Iron Foundry, thirteen of the mortar bodies were shipped by the South Boston Iron Works to the Builders' Iron Foundry prior to June 30, 1892.

The remaining twenty-three of the contract of August 19, 1889, and one of those received from Boston were finished and assembled during the fiscal year ended June 30, 1892. Inspection reports, showing detailed dimensions of these mortars, have been forwarded to the Ordnance Office.

By contract of June 22, 1891, the Builders' Iron Foundry undertook to furnish the United States eight spring return 12-inch mortar carriages at $11,500 each, the first one to be delivered December 22, 1891, and the others at the rate of one every six weeks thereafter. None of these carriages were received during the fiscal year, and an extension until March 29, 1893, has been granted the company, the first carriage to be finished August 31, 1893, and the others at intervals of four weeks.

In the construction of the mortars the main operations are probably very similar to those employed elsewhere, but as some of the minor methods may present features of interest, a brief description is given:

TURNING BODY FOR A HOOPS AND ROUGH-BORING OF MORTAR.

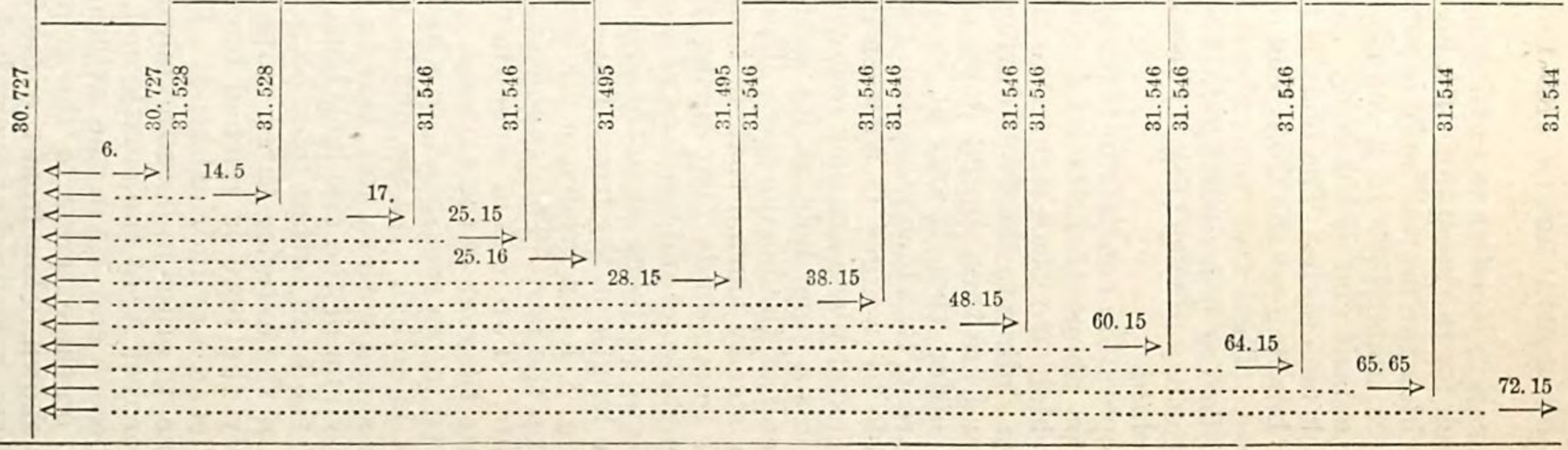
The first operation consists in cutting a notch near the outer edge of face of breech for the reception of a hook secured to the headstock face plate, by which the mortar body is rotated. A hat piece, having a very slight taper, about 0.02 in a length of 4 inches, is next driven firmly into the muzzle end of the bore. A similar hat piece is bolted to the headstock face plate. The body is then placed in the lathe. A center piece or bushing on the front end of the boring bar enters the muzzle hat piece. The latter turns about the former when the mortar revolves. The boring bar abuts against a shoulder on the outer end of the center piece, and thus (Fig. 1) keeps the mortar bearing against the lathe face plate.

The second operation consists in turning down the breech end to the finished size for about 15 inches for the reception of a clamp ring (two halves), which are then secured to the face plate by bolts to keep the mortar from sliding to the front during the boring. About 6 inches of the muzzle end are then turned down cylindrically to a diameter of 24 inches, in order that it may fit in a rest, A, Fig. 2. This rest fits in another rest, B, which stands on the ways of the lathe and is made adjustable by wedges C between it and the ways. The muzzle hat piece and center piece are now removed. The hat piece bolted to the face plate has a taper hole at its center for the reception of the tapered front end of the boring bar. The rear end of the boring bar is secured to a steady journal that is firmly clamped to the tailstock. The boring bar thus stands fast during the operation of boring. A washer between its front and the face plate hat piece diminishes friction between these two surfaces when the latter revolves. A feather key runs the entire length of the bar. The cathead, or head carrying the boring tool, Fig. 3, has a groove on its inner surface for the reception of the feather on the bar. This enables the head to slide along the bar, but not to rotate. Two rods of somewhat greater length than the bore are screwed into the rear of the cathead. The rear ends of these same rods are screwed into a crosshead, to which a nut on the feed screw in the tailstock is bolted. As the nut is fed forward or backward it carries the crosshead with it, and this in turn operates the cathead, through the medium of the two long bars. The boring is done by the withdrawal of the head rather than by a forward push. During the turning down of the exterior three chips are taken with the boring tool, and finally the bore is reamed once. The reamer has several cutting edges let in a cylindrical head. The gun is next turned end for end in the lathe, in order to bore the powder chamber. In this operation the interior rest A, at the muzzle end, is removed and the clamp (ring) on the breech end fits in the exterior rest B, Fig. 1. After the body is turned on the exterior to the required dimensions, which are determined as shown below from the interior diameters of the A hoops, these having been measured at every inch in the length of the hoops and in two directions at right angles to each other, it is calipered by the inspector at every inch of its turned length on two diameters, also at right angles to each other, to verify the accuracy of the work.

A table similar to the following, except that the actual interior diameters of A hoops are entered instead of the standard, is furnished the company by the inspector, a duplicate copy being retained by him:

Diameters of shrinkage surfaces of cast-iron body No. 280 for mortar No. 175; from interior diameter of A hoops.

Designation of hoop.	12 MR 50 A_5.						12 MR 50 A_4.	12 MR 50 A_3.	12 MR 50 A_2.	12 MR 50 A_1.		
Lengths	Rear, 6″.0	8″.5	Cone, 2″.5	8″.15	0″.01	Front, 2″.99	10.0	10.0	12.	Rear, 4.0	Cone, 1″.5	Front, 6″.5
Mean interior diameter of hoop	30.7	31.5	.....	31.5	.....	31.45	31.5	31.5	31.5	31.5	.....	31.5
Prescribed shrinkage	0.029	0.030	.....	0.047	.....	0.046	0.047	0.047	0.047	0.047	.....	0.047
Required diameter of body	30.729	31.530	.....	31.547	.....	31.496	31.547	31.547	31.547	31.547	.....	31.547
Allowed variations	+.001 / −.002	+.001 / −.002	.....	+.002 / −.001	.....	+.002 / −.001	+.002 / −.001	+.002 / −.001	+.002 / −.001	+.002 / −.001	.....	−.003
Maximum limit	**30.730**	**31.531**	.....	**31.549**	.....	**31.498**	**31.549**	**31.549**	**31.549**	**31.549**	.....	31.547
Minimum limit	30.727	31.528	.....	31.546	.....	31.495	31.546	31.546	31.546	31.546	.....	**31.544**
	6.0	8.5	Cone, 2″.5	8.15	0″.01	2.99	10.	10.	12.	4.	1″.5	6.5



Preferred limit in black figures.

The A hoops having been shrunk on, as will be explained later, the bore is star-gauged to ascertain the compression due to the hoops, and the exterior diameters of the hoops are measured to find the increase due to their expansion over the body. The mortar is then returned to the lathe.

TURNING DOWN EXTERIOR OF A HOOPS.

For turning down the exterior of A hoops the arrangement is the same as that for turning down the rear portion of the cast-iron body, the same lathe being used. A table for the required dimensions from the interior diameters of the B hoops, similar to the following, governs the workman as in the turning of the mortar body. When finished the exterior is calipered by the inspector as before. The mortar is then transferred to the hooping room and the B hoops are shrunk on. The bore is again star-gauged and the exterior diameters of the B hoops measured to determine their increase in length.

Diameters of shrinkage surfaces of A hoops assembled; from interior diameter of B hoops. Mortar No. 175.

Designation of hoop.	12 MR 50. B_6		12 MR 50. B_5			12 MR 50. B_4	12 MR 50. B_3		12 MR 50. B_2	12 MR 50. B_1
Lengths	Cone, 2″.0	Front, 10″.0	Rear, 2″.25	Cone, 3″.0	Front, 4.10	9″.35	Rear, 7.45	Cone, 2″.0	14″.0	7″.25
Mean interior diameter of hoop	36.25	36.25	36.25	.....	36.25	36.25	36.25	.....	36.25	36.25
Prescribed shrinkage	0.024	0.019	0.019	.....	0.049	0.049	0.049	.....	0.043	0.043
Required exterior diameter of A hoops	36.274	36.269	36.269	.....	36.299	36.299	36.299	.....	36.293	36.293
Allowed variations {	+.002	+.002	+.002	.....	+.001	+.001	+.001	.....	+.001	+.001
	−.001	−.001	−.001	.....	−.002	−.002	−.002	.....	−.002	−.002
Maximum limit	36.276	36.271	36.271	.....	36.300	36.300	36.300	.....	36.294	36.294
Minimum limit	**36.273**	**36.268**	**36.268**	.....	**36.297**	**36.297**	**36.297**	.....	**36.291**	**36.291**
	2.0	10.0	2.25	3.	4.10	9.35	7.45	2.	14.0	7.25
2.75	36.273		36.268	36.268	36.268	36.268	36.297	36.297	36.291	36.291
.....		4.75								
.....				14.75						
.....					17.					
.....						20.0				
.....							24.10			
.....								33.45		
.....									40.9	
.....										42.9
.....										
.....										56.9
.....										
.....										64.15

Preferred limit in black figures.

TURNING DOWN EXTERIOR OF MORTAR.

[B hoops and chase.]

For turning down the exterior of the mortar another lathe is employed. A bushing, Fig. 4, sufficiently long to reach the front end of the powder chamber and to project about 18 inches to the rear of the mortar, and of an exterior diameter nearly equal to the bore of the chamber, is inserted from the rear. The front end of the bore of the bushing is a conical frustum with its larger base to the rear. Three slots are cut entirely through the conical end of the bushing to admit of its expansion in the bore. A long rod, with a corresponding frustum on its rear end, extends from the bushing clear through the bore of the mortar, the lathe spindle in its muzzle, and through the headstock of the lathe. The outer end of the rod is threaded for a nut, which bears against the headstock and by means of which the mortar is drawn firmly to its place. At the same time the frustum on its rear end expands the front of the bushing tightly in contact with the bore of the mortar. An arbor or tail center inserted in the rear end of the bushing, in which it closely fits, rests on a support on the ways of the lathe and sustains the rear of the mortar. The muzzle end of the mortar is sustained by the lathe spindle, which in turn rests on another support on the lathe ways.

Two tool carriages are employed, one for the B hoops and one for the cast-iron chase, the latter being inclined to the axis of the bore to give the necessary taper to the chase.

BORING OF THE HOOPS.

The hoops are boredand faced in boring mills, whose tables, to which the hoops are firmly secured, revolve in a horizontal plane. The tool carriage is above the level of the table. A portion of the A hoops were bored on a lathe, but the work was unsatisfactory, the turned surface being rough and the bore often eccentric, the latter due, it is thought, to the weight of the hoops, causing them to elongate when the hoops stood on their sides. The hoops are first faced on one end. They are then turned over so as to rest on the squared surface when they are bored, and the other end faced off, bringing them to the prescribed length. When taken from the mill they are laid flat on the floor and the mean interior diameters determined by measuring on two diameters at right angles to each other at every inch of the length of the hoop. The trunnions of the trunnion hoop are turned in a lathe before the hoop is bored. Its exterior is afterwards finished in a slotter.

HOOPING OF THE MORTARS.

The mortar is placed on a truck running on a railway track leading from the lathe to the heating pit. It rests on a single support on the truck, Fig. 5, somewhat in advance of the position that the hoops will occupy. A strap over the muzzle and secured to the truck prevents the breech from coming in contact with the truck, thus leaving the rear end free to receive the heated hoops. A trolley rail runs immediately over the axis of the truck, on which five trolleys are placed. To each of these a Yale triplex pulley hoist is connected. The first supports the side screws of the press for drawing the hoops into their proper positions and holding them there while cooling. The second supports a water ring, pierced with small holes, by which the hoops are

cooled. The third sustains the hoop while being slipped on the mortar, and the fourth the collar which bears against the hoop to force it to its position. The fifth is used to lower the hoop into the heating pit and to transfer it from the pit to the floor immediately in rear of the mortar. The press consists essentially of a crosshead or equalizing bar at the muzzle of the mortar, two heavy side bars, somewhat longer than the mortar, and the collar. The ends of the crosshead are bored to admit the side bars. The front ends of the bars are threaded for nuts, which, through the intervention of ball-bearings, abut against the crosshead. The rear ends of the bars are T-shaped to lock into recesses cut in the sides of the collar.

THE HEATING PIT.

The pit is about 2 feet deep and 7 feet in diameter, and is lined with sheet iron. On its bottom are four tracks for small carriages carrying the gas burners. These are practically Bunsen burners on jointed pipes. One row is thrown against the interior of hoop and one against its exterior. The fuel is the ordinary city gas mixed with air driven in by a blower.

The operation of hooping is as follows: The mortar is placed in position on the truck and its bore closed front and rear, the plugs being connected by a long rod with head on one end and nut on the other. Two holes in the front plug receive pipes, one to admit water to the bore and the other to act as an overflow. A clamp ring (two halves) is clamped around the hoop. This is attached to the rear trolley. The hoop is then run over the pit and lowered into position. The pulley hook is detached, the gas lighted, and air admitted until the color of the flame indicates a sufficiency, when a sheet-iron cover is placed over the pit. At frequent intervals the cover is removed and a gauge rod of minimum prescribed length applied by the foreman. When the rod enters the hoop the latter is quickly hoisted from the pit and run to near the breech of the mortar and laid on the floor. The pulleys are cast off and trolley No. 5 run to the rear. The inspector then tries his gauge, and notes the change from the prescribed minimum length. The collar is then run to the rear of the hoop and the latter is connected with trolley No. 3, raised and entered on the mortar and run to position. The collar is next run up in rear of the hoops. The side screws are quickly connected with it, and by means of long levers the nuts on the screws are turned so as to bring the collar against the hoop and the latter into its position. The water ring is then run over the front end of the hoop and the water is turned on. During the cooling the levers are frequently turned to force the hoop well forward. From the time the hoop leaves the pit to that at which it is fully in position and the water turned on hardly more than two minutes elapse. About twenty minutes are required to heat the hoops, and nearly the same time to cool them.

FINISH BORING.

The mortar is finished bored in a third lathe, the arrangements for holding it being as follows: To the face plate a flanged muzzle collar is secured by bolts through holes in flanges. The muzzle of the mortar enters the collar while the breech rests in a semicircular support on the ways of the lathe. Heavy iron straps, having loops over the trunnions, are secured to the face plate. This prevents the mortar from working to the rear during its rotation. Set screws through the sides

of the collar enable the muzzle to be shifted if necessary. Wedges under the rear support, connected by screws, afford means of slightly shifting the breech if required.

To insure the axis of the mortar being in the axis of revolution, and also for determining if the bore be straight, an indicator, Fig. 6, is used. This consists of a triangular-shaped arm pivoted at its lower front in an attachment to the front end of the boring bar and carrying a roller whose axle passes through the pivot. To the upper end of the arm is attached a hair wire, terminating in a spiral spring, which is fastened to a flat table. A needle connected with the wire rests on a graduated scale on the table. As the mortar revolves the roller bears against the surface of the bore causing the needle to move over the scale if there be any variation in the pressure of the roller against the bore. The mortar is then shifted if necessary until the needle stands fast during the rotation, which it will do if the bore be straight. Indications are taken at every 6 inches of its length.

During the finish boring kerosene oil is forced through a pipe into the interior of the reamer, which is hollow, and from which it escapes through small holes against the sides of the bore.

RIFLING OF THE MORTAR.

During the rifling the mortar is placed in two semicircular supports, resting on a system of compound wedges connected by screws, to admit of changing the position of the supports if necessary. The rifling machine consists essentially of a frame to which is attached in a horizontal position the developed curve Fig. 7 of the rifling in the shape of an iron rail about half an inch thick, a hollow rifling bar carrying the cutter head and cutter, a driving screw, a worm and gear for rotating the bar during its motion of translation, and the driving mechanism connected with the belt from the main shaft. At the rear end of the rifling bar and rigidly connected with it is the worm gear, having on its periphery thirty-four teeth. The worm, which is connected with the developed curve by rollers bearing on both sides of the rail, acts on the worm gear precisely as a rack on a pinion, except that each time the bar is withdrawn from the bore the workman gives a half turn to the worm by a handle which has a snap fastening, thus rotating the bar $\frac{1}{68}$ round and causing the cutter to enter another groove. The guide rollers at the outer end of the worm are held in close contact with the rail by spiral springs attached to the ends of a cross piece pivoted immediately above the axis of the bar. A motion of translation is given the rifling bar by the driving screw, which enters the bar and runs its whole length, the central portion of the worm gear serving as a nut. The driving screw is operated by a friction pinion meshing with a sort of internal and external friction gear on the rear of the screw. This gear consists of two friction pulleys of different diameters bolted together and having V-shaped grooves on their surfaces. When the pinion is thrown in contact with the exterior of the small central pulley the screw is rotated to the right and fed rapidly through the bore until a shifter is struck, when the pinion is thrown against the interior surface of the larger pulley and the reverse motion takes place, but with a slower feed. At the same time the head of the bar strikes against a buffer and sets out the cutter which forms the groove on the slow-feed return, the cutting being done by a pull rather than by a push. A collar on the screw a little in advance of the friction gear and inclosed between ball bearings in a box connected with the bed

of the machine takes the thrust and draw of the screw. The mortar is held in contact with the rifling machine by iron straps leading from the trunnions to the frame of the machine. A cross piece in front of the muzzle also attached to the trunnions by straps serves as a buffer to feed out the rifling tool. An electric circuit runs the length of the machine with push buttons every 3 or 4 feet. The breaking of the circuit releases a clutch that is held up by electro-magnets and throws the driving screw out of gear and stops the bar. The workman can thus stop the operation from any position along the side of the machine.

CUTTING THE THREADS IN THE BREECH.

The mortar for this operation is placed in supports similar to those employed in the rifling. A cross piece passes over the muzzle and is secured by straps to the trunnions. To this cross piece and forming a part of it but at right angles to it is a lead screw having the pitch of the threads on the breechblock, the screw having been cut in the same lathe and with the same pitch screw as the threads on the block. The cutter bar is hollow, but has attached to its front end a nut that engages with the screw of the cross piece. The cutter bar is steadied by two bushings in the bore of the mortar. The forward one revolves with the bar but the latter is fixed in the bore. As the bar is driven forward by the power applied to its rear it is compelled to rotate by its nut engaging with the screw. The bar is loosely connected with the driver, so that it centers itself in the bushings. A cutter on the bar cuts the threads in the breech. When the thread is finished the bushings, etc., are removed and one segment slotted out by the same machine, the bar no longer rotating. The mortar is then rotated 120 and a second segment removed and so on. A Whitworth quick-return motion is given the cutter bar in this machine.

REAMING PROJECTILE CHAMBER.

The mortar is then returned to the lathe, in which it was finished bored, where the long (30 inch) reamer is applied. This, as well as all other reamers, consists simply of a head in which are let several cutting edges the length of the reamer. They are secured in dovetailed grooves.

BREECH MORTISING.

The seats for segmental rack and hinge block and guide groove for vent-cover stud are milled out with a machine, Fig. 8, prepared specially for the purpose, and which, during the operation, is rigidly connected with the mortar itself. The latter rests on blocking at a convenient height. A bushing threaded at its rear to mesh with threads in the breech recess and of an exterior diameter at its front to give a close fit in the bore is inserted in the breech. The rear of the bushing is slotted partly through, both radially and circumferentially. Wedges in the circumferential slots are operated by screw bolts, so arranged that the bushing, which springs to some extent, may be firmly secured, its axis being in that of the mortar. An arbor in the bushing supports the milling machine proper. A rod in the axis of the arbor passes through a yoke at the of the bushing. It is secured to the yoke by a shoulder on the inner and a nut on the outer side. A screw with projecting handle square that enters the arbor at its rear and screws into the rear end of the rod serves by means of collars to give a longi-

tudinal motion to the arbor, and consequently to the machine which is connected with it by set screws. A longitudinal slot in the rod near its rear permits motion of the main driving shaft. A rope with counterpoise attachment holds the machine in any position. Power is applied by means of an idler as the position of the driving pulley changes with the rotation of the machine. An additional contrivance strapped to the mortar and connected with the milling machine makes the feed of the latter automatic. Jigs attached to the face of the breech limit the movement of the cutter. The operations of boring, threading, slotting, milling, etc., of the breechblock and its connections present no unusual features and are, therefore, not described.

Sketches illustrating above operations are appended.

Very respectfully, your obedient servant,

JOHN E. GREER,
Captain, Ord. Dept., U. S. Army, Inspector.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

(5364–'92.)
ORD 92——37

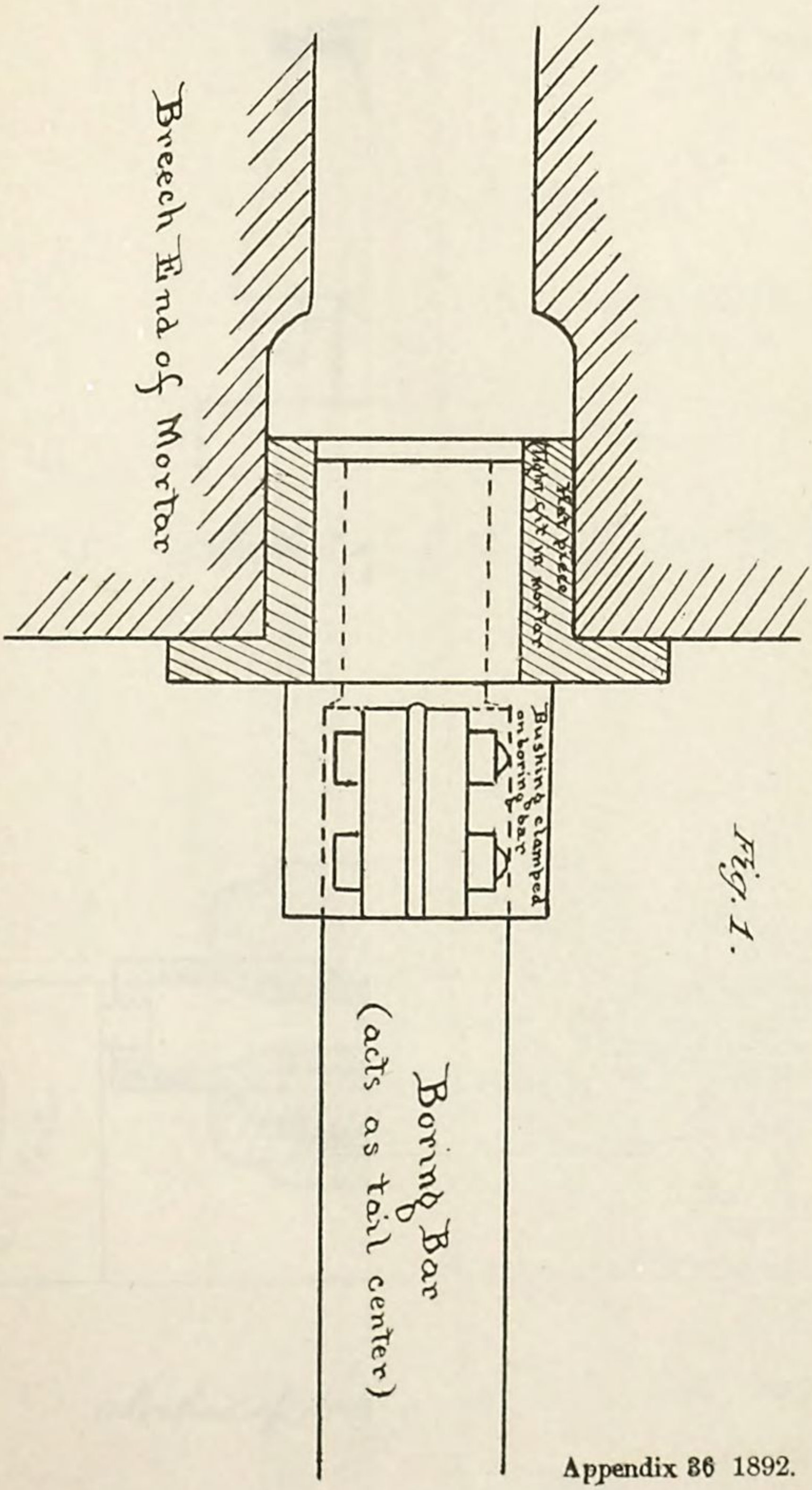
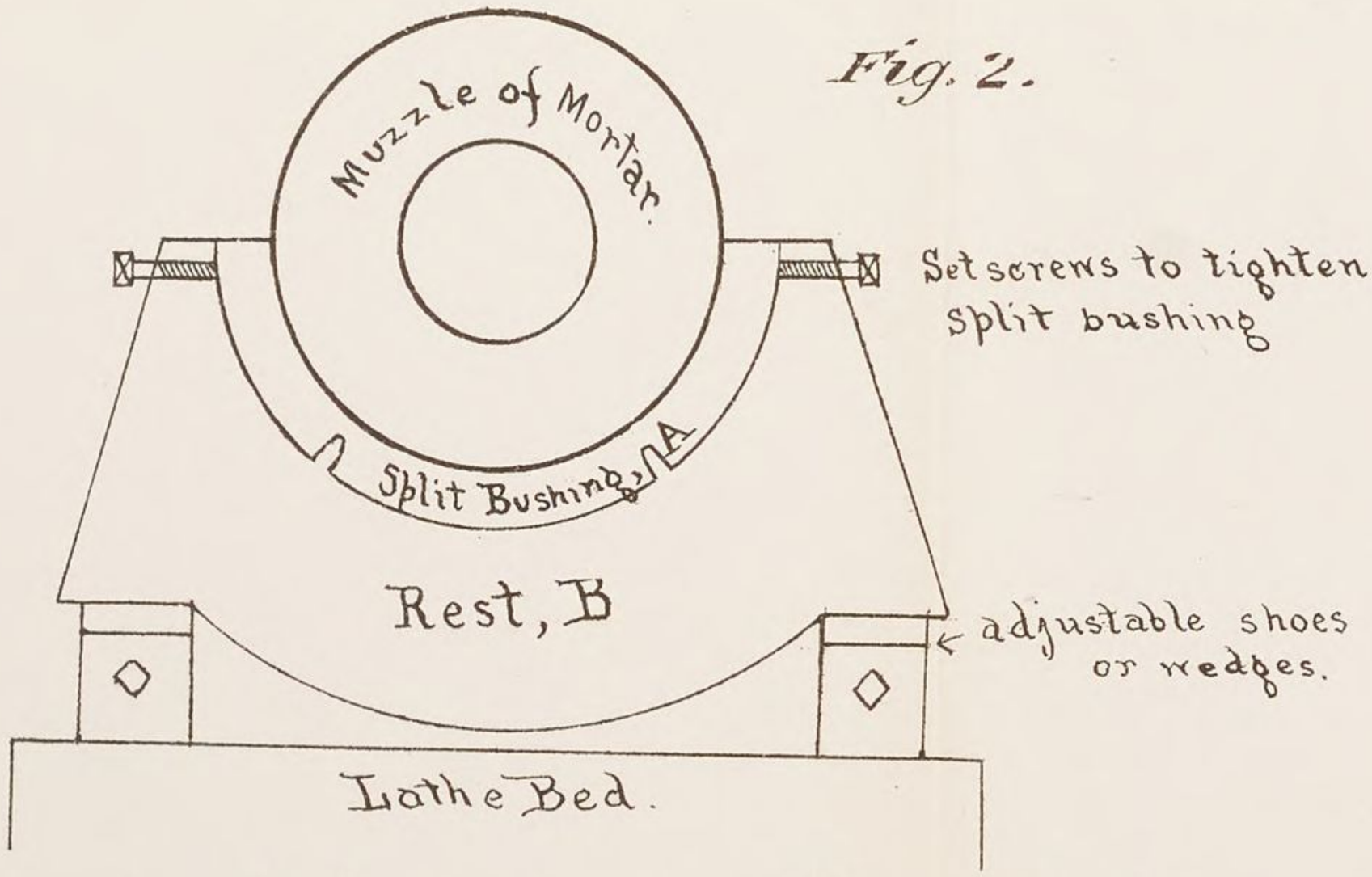


Fig. 1.

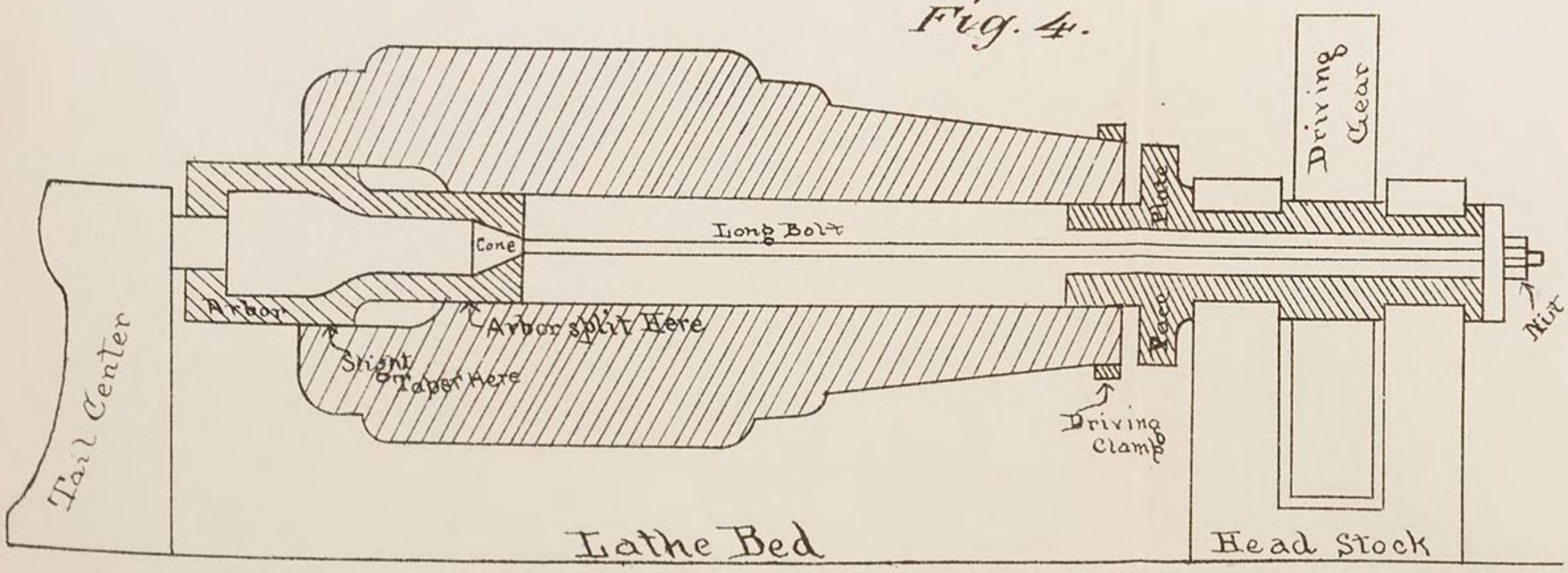
Method of holding Breech End while Turning Shank & Lugs.

Fig. 2.



Method of Holding Muzzle of Mortar while boring.

Fig. 4.



Appendix 36, 1892.

Method of Holding Mortar while turning exterior.

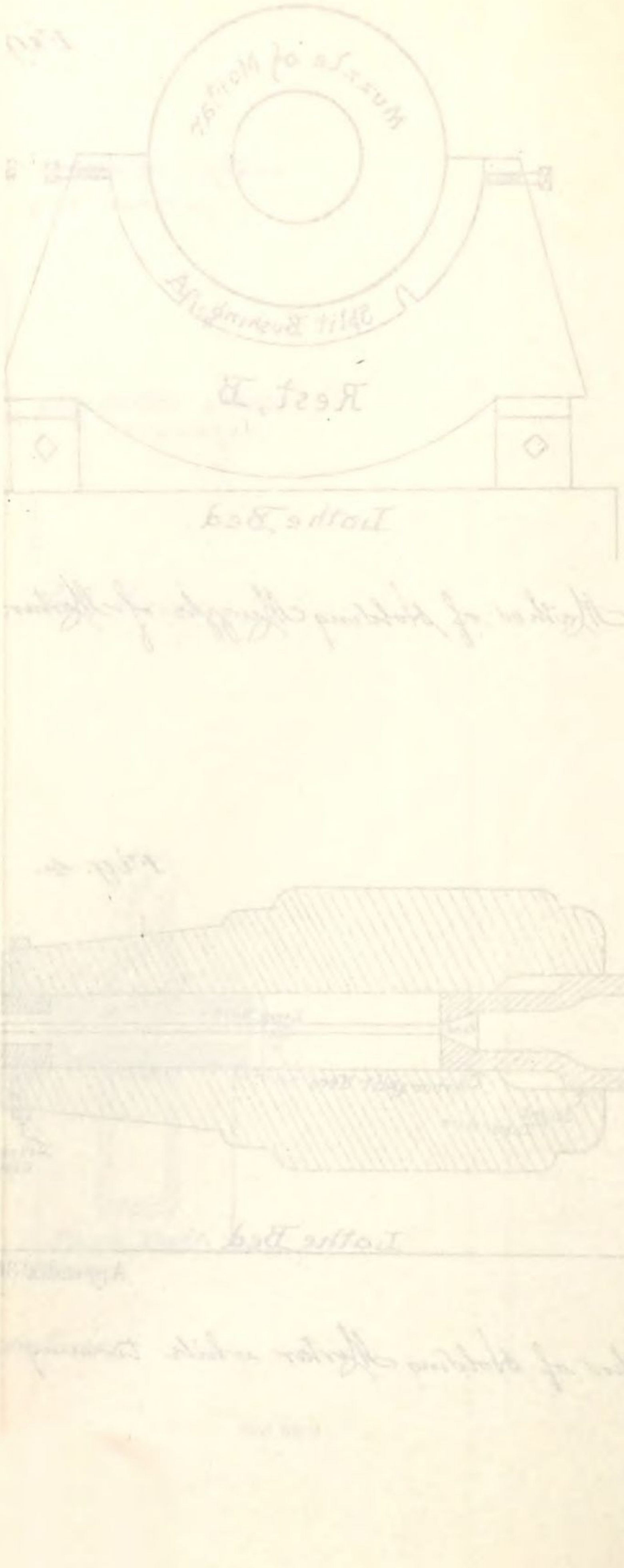
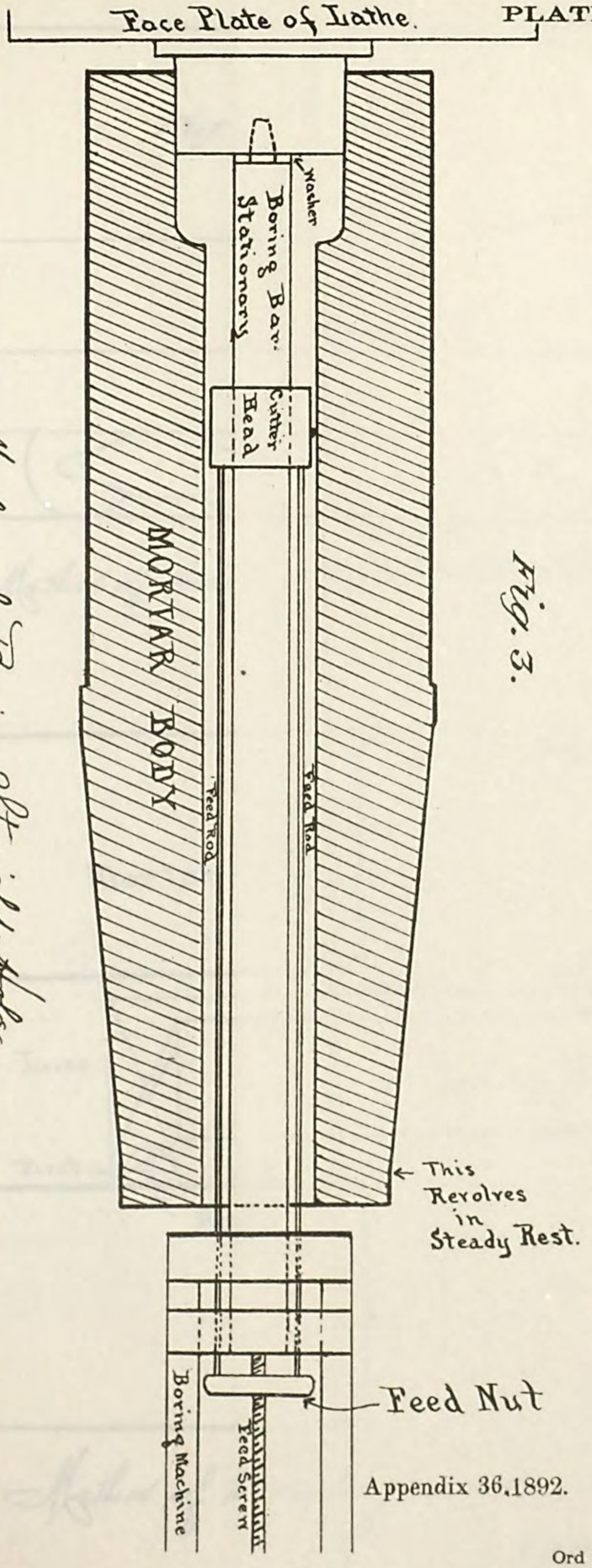


PLATE III.

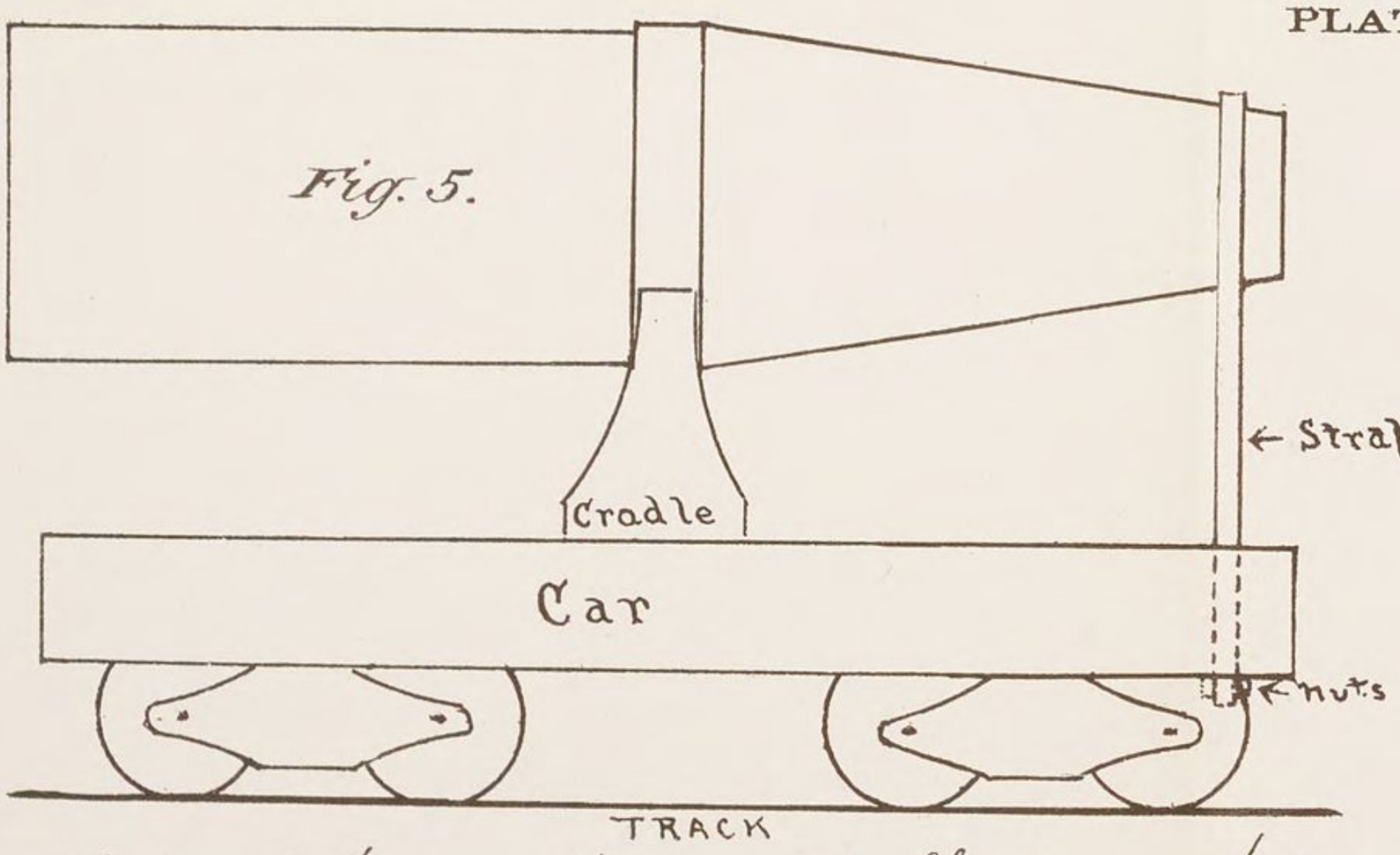
Method of Boring Straight Holes.

Fig. 3.



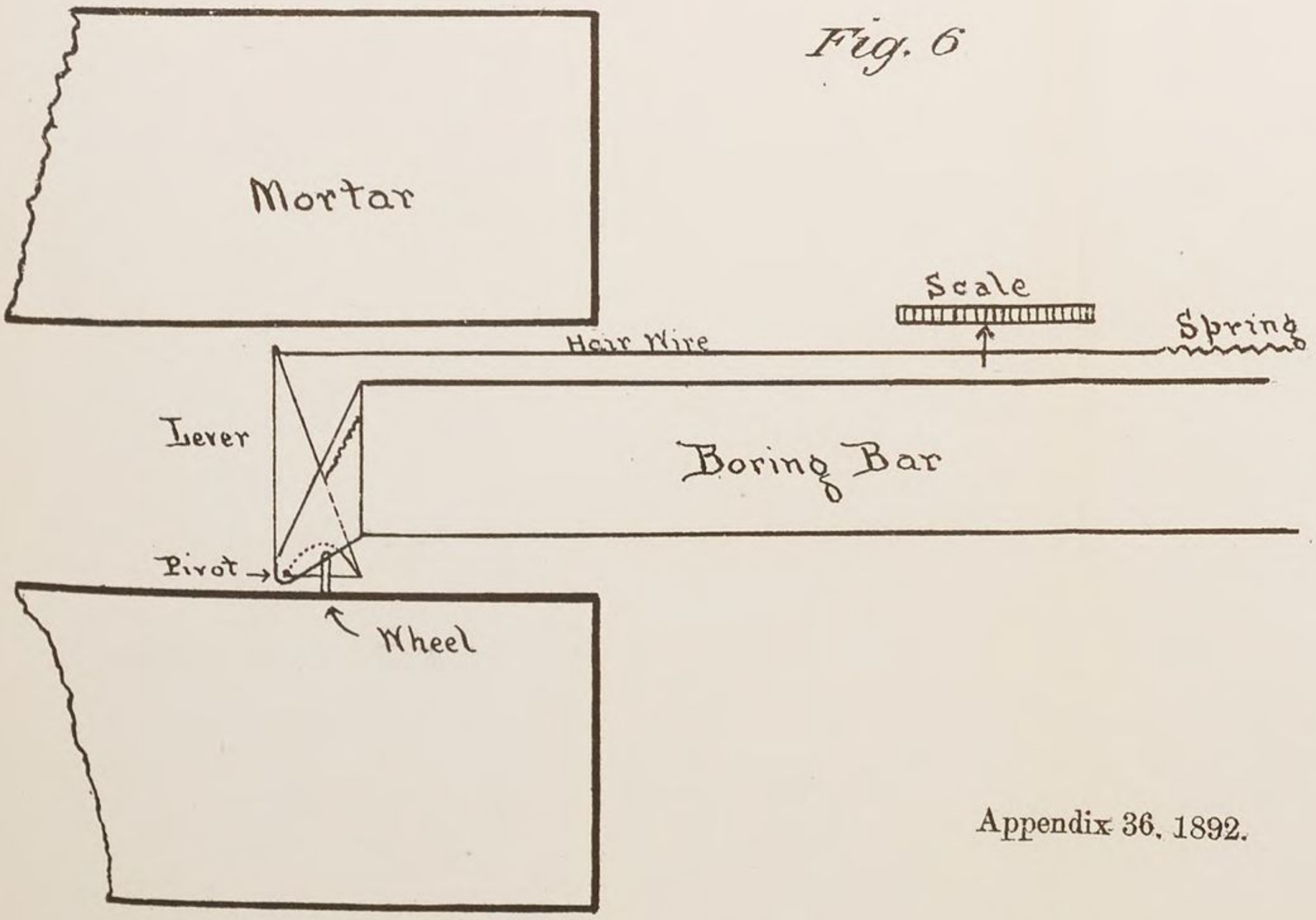
Appendix 36, 1892.

Fig. 5.



Method of Holding Mortar while Shrinking on Hoops

Fig. 6



Appendix 36. 1892.

Method of indicating eccentricity of bore

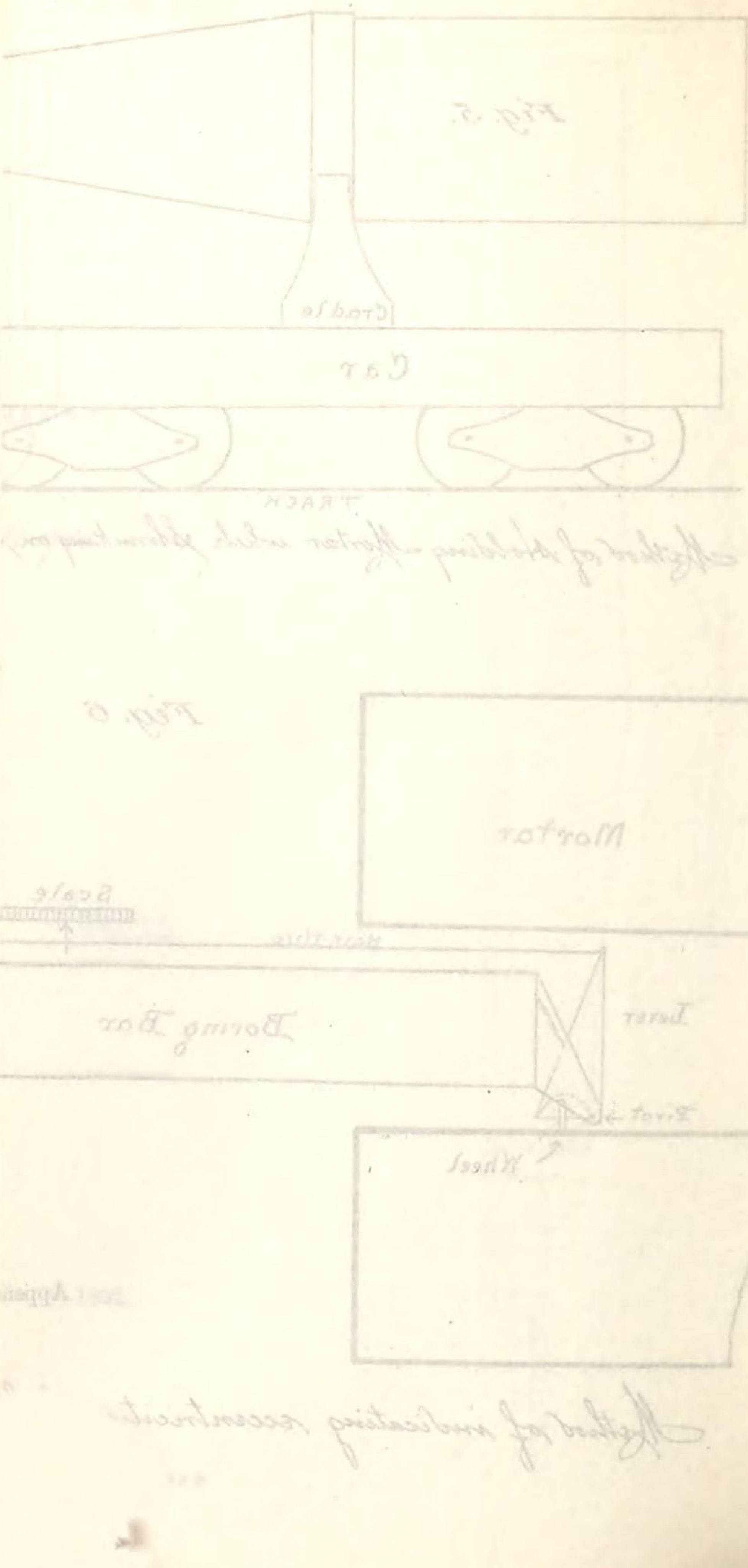


Fig. 7.

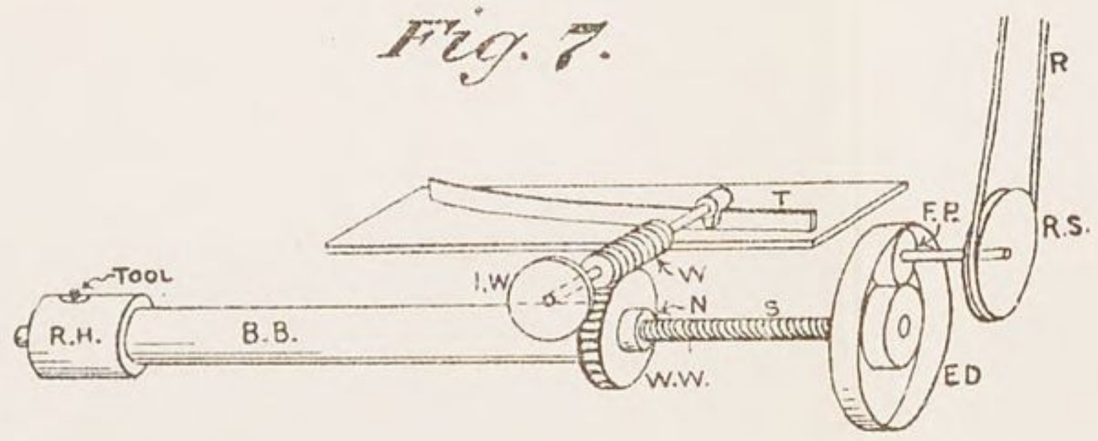
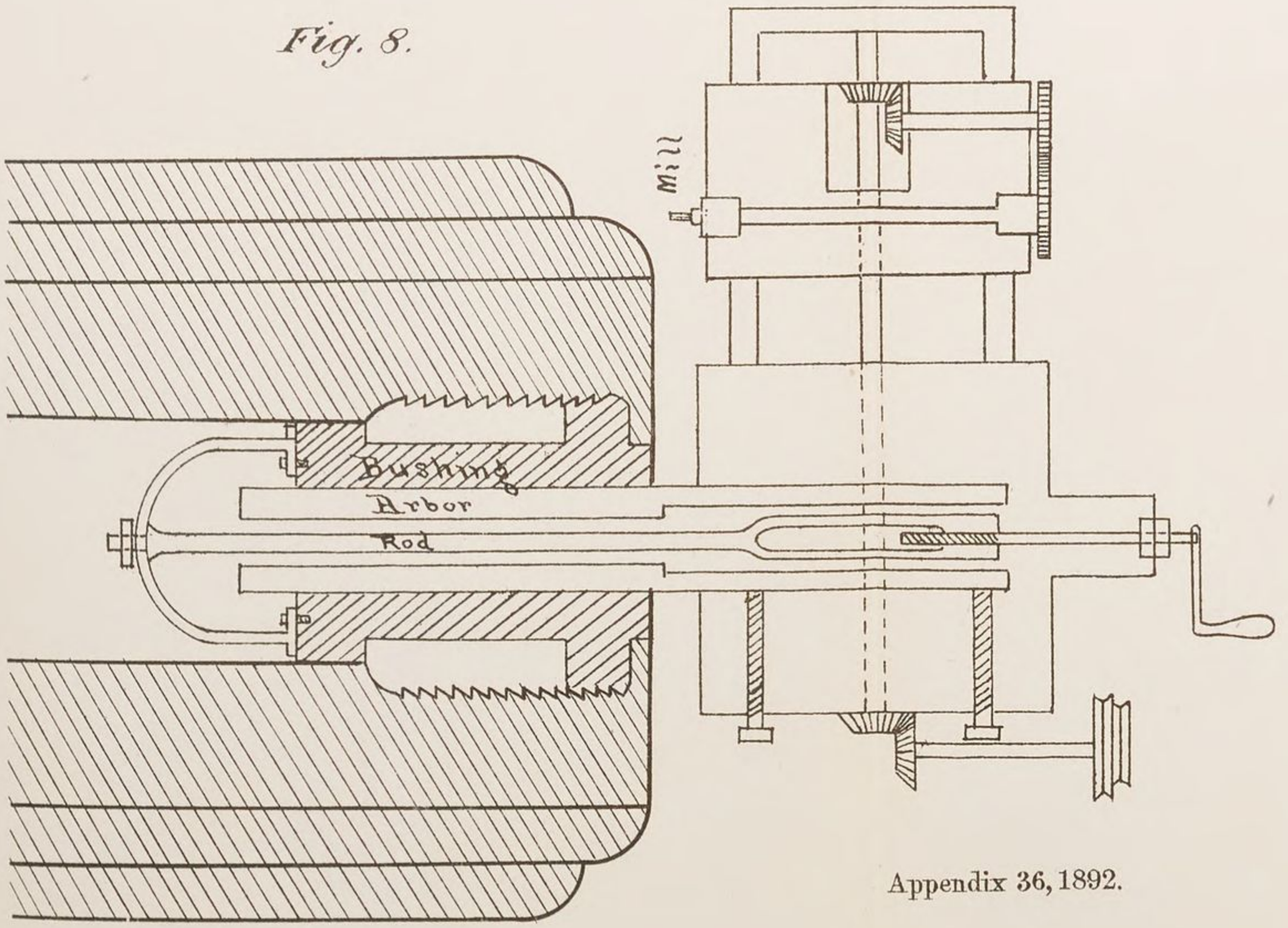
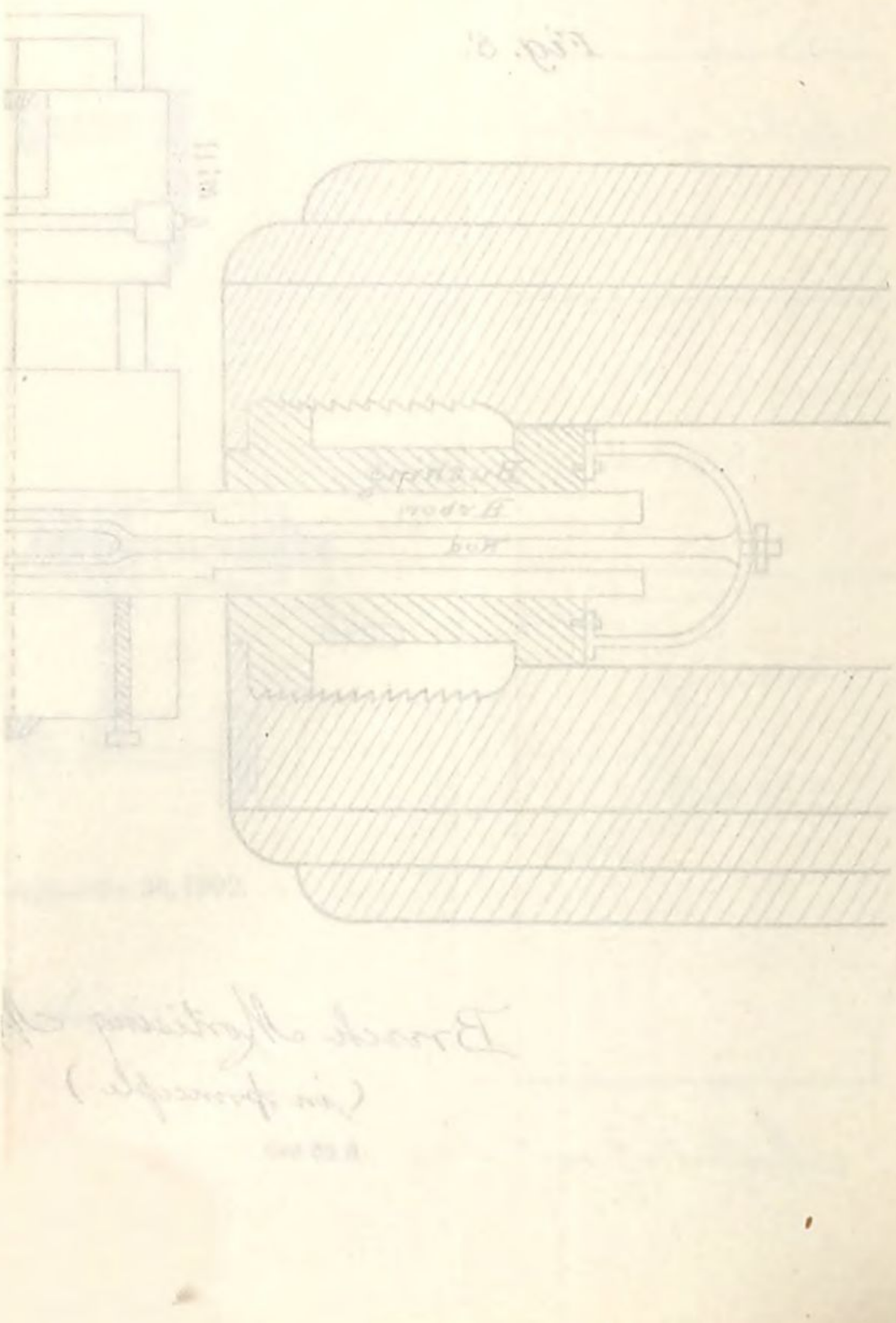


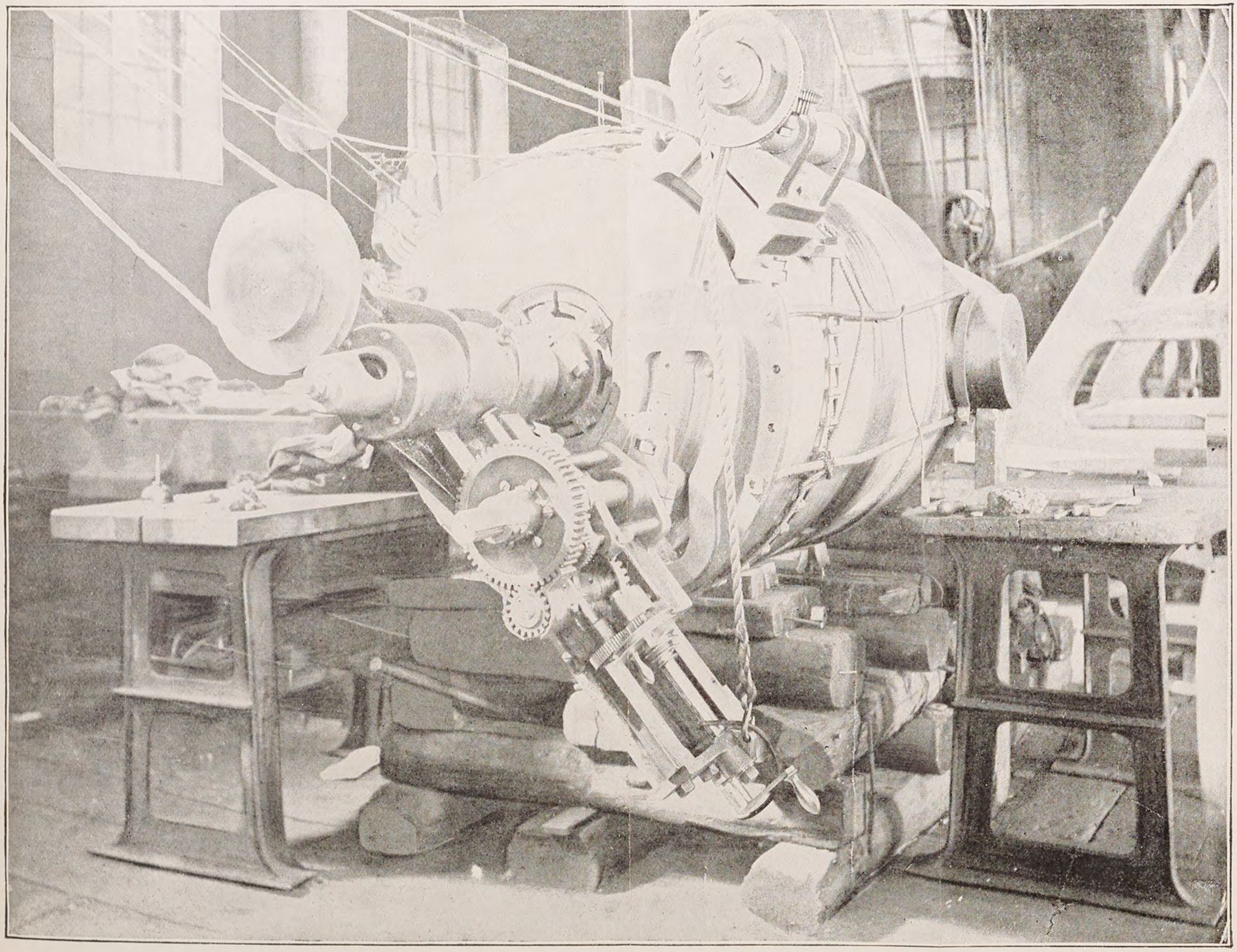
Fig. 8.



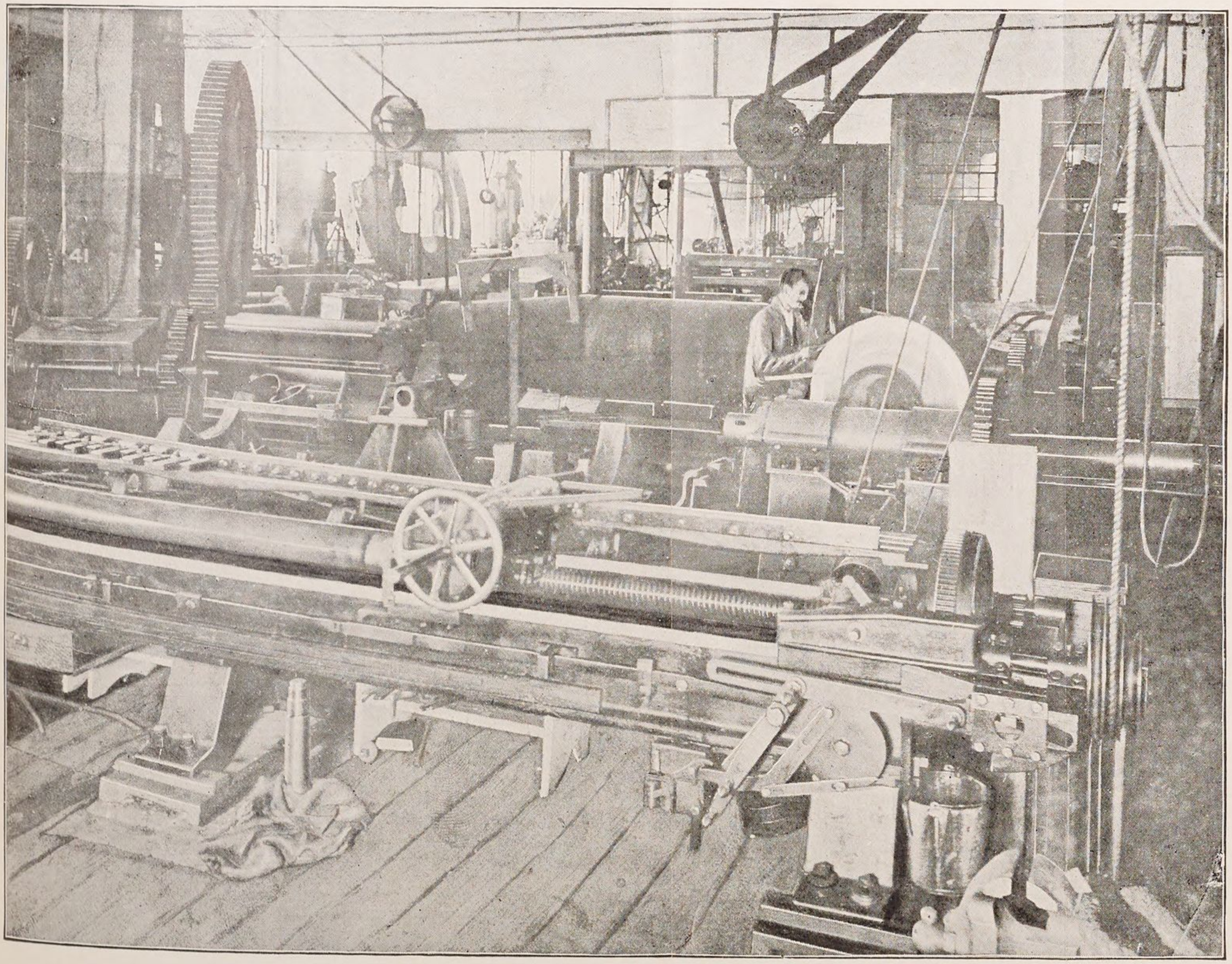
Appendix 36, 1892.

Breech Mortising Machine
(in principle)





BREECH MORTISING MACHINE.



RIFLING MACHINE.

APPENDIX 37.

PROGRESS REPORT ON THE MANUFACTURE OF ORDNANCE AT THE WEST POINT FOUNDRY, COLD SPRING, N. Y.

(7 plates.)

OFFICE OF INSPECTOR OF ORDNANCE, U. S. ARMY,
WEST POINT FOUNDRY,
Cold Spring, N. Y., October 4, 1892.

MANUFACTURE OF ELEVEN 8-INCH B. L. STEEL RIFLES, MODEL OF 1888, CONTRACT DATED DECEMBER 5, 1890.

The condition of the work on this contract at the beginning of the fiscal year which ended June 30, 1891, was as follows: Gun No. 1, jacket and hoop C assembled; gun No. 2, jacket assembled; three jackets, 5 C hoops, 1 D hoop, and 3 A hoops finished for assembling, and various other parts in progress in machines.

The condition of the work at the end of the fiscal year was as follows: Gun No. 1, completed and shipped to Sandy Hook June 6, 1892; gun No. 2, practically finished except fitting the breech mechanism (this gun was completed and shipped to Sandy Hook July 27, 1892); gun No. 3, finished except rifling, finish boring powder chamber and finishing and fitting breech mechanism (this gun is now finished and ready for shipment); gun No. 4, jacket, C and D hoops assembled; gun No. 5, jacket, C and D hoops assembled; gun No. 6, jacket and C hoops assembled; gun No. 7, jacket and hoop C assembled; gun No. 8, jacket and hoop C assembled; gun No. 9, jacket and hoop C assembled; gun No. 10, jacket ready for assembling; gun No. 11, jacket ready for assembling; thirty-two hoops finished ready for assembling; progress on breech mechanism in such condition as to be ready for fitting to the guns as soon as they shall be completed up to this stage of the manufacture.

MANUFACTURE OF ONE SEABURY BREECH MECHANISM FOR 5-INCH SIEGE RIFLE, CONTRACT DATED JULY 7, 1891.

This work was completed during the fiscal year, and the gun was finally accepted December 18, 1891.

The description of the Seabury breech mechanism for 5-inch siege rifle is as follows, references being to the six plates accompanying this report:

A, a hinge bracket rigidly secured to the face of the gun breech, having two arms projecting rearward.

B, a crank keyed on pivot or hinge-pin (B^{vi}).

C, a rack with downward projecting teeth, moving on a horizontal guide (E) on the rear face of the gun.

D, a rack link connecting the rack (C) with the crank pin (B^{iii}) to communicate the latter's motion to the former.

E, a guide-slide rigidly secured horizontally to the breech face to direct the movement of the rack (C).

F, a face plate having teeth (to engage C) on 60° of its periphery, rigidly secured to the rear face of the block.

G, a retractor, the two arms of which embrace the upper arm of the hinge bracket (A), above and below, with corresponding holes to receive the pivot (B^{vi}), upon which it has free rotary movement.

H, a return bolt having vertical motion through holes (as guides) in the two arms of the retractor (G) near the pivot (B^{vi}). This bolt has a short arm perpendicular to itself, working in a cam slot (A^{i}) cut in the upper arm of the bracket (A), and by this means is raised or lowered during the motions of opening and closing the breech. Its guide key is a short projection, in line with the cam arm, working in the slot in the upper arm of the retractor. A short coiled spring is placed under the cam arm to allow for wear on the head of the bolt.

I, a retractor box connected through the bolt (J), with free turning movement, to the recess in the rear face of the breechblock.

J, a retractor box bolt, having each end squared, passing vertically through holes in the retractor box (I) and the retractor link (K). The square ends of this bolt are in a groove formed between the turned recess in the rear face of the breechblock and the abutting face of the face plate (F), which latter has slots on opposite sides of its inner circumference, through which the ends of the bolt may be withdrawn when the retractor box (I) containing it has been turned to a position allowing such withdrawal. This, however, can only occur when the retractor (G^{i}) is disconnected from the retractor link (K), or from the pivot (B^{vi}) by removing the latter.

K, a retractor link serving as a connection between the retractor (G) and the retractor box (I) (by the bolt J) and the breechblock, for movement of the latter in or out of the gun.

L, a retractor bolt connecting the retractor (G) with the retractor link (K). (Bolt entered from below.)

M, a tray of ordinary pattern, with latch to block and gun as usual resting on the lower arm of the bracket (A), with free turning movement on pivot (B^{vi}).

N, a tray latch serving to automatically lock and unlock the tray to and from the gun as usual.

O, a tray locking stud to engage the hook of latch (N).

P, an extractor plate with longitudinal movement (when breech is open) in a guide recess below the lowest screw blank in the gun, having at its inner or forward end projections or collars, the longer (P^{i}) formed to embrace a portion of the cartridge-case head, and the other (P^{ii}) to engage a corresponding projection or collar on the nose of the breechblock, which projection is cut away 60° at the bottom of the block (when unlocked) to allow the block to pass freely to its position. The other end of the extractor plate is slotted to receive the upturned pin (Q^{ii}) of the extractor lever (Q).

Q, an extractor lever having two arms which embrace the lower arm of the bracket (A) and receive therewith the pivot (B^{vi}). To this lever is pivoted on its upper arm an extractor hook (Q^{i}), which engages in the slot (M^{i}) cut upon the sleeve of the tray (M) below its horizontal web.

R, an extractor lever bolt serving as a pivot for the extractor lever (Q), also as a spindle for the extractor spring (R^{i}), which serves to return the extractor lever and plate to their normal positions, as well as

to cause the extractor hook (Q^i) to bear upon the sleeve of the tray (M) ready for action.

S, a firing pin working in an axial hole in the breechblock and in the longitudinal guide hole in the retractor box (I). It is actuated by a spring (S^i) riveted to its shoulder and working against a recessed shoulder in the retractor box (I).

T, a cocking cam secured to the bottom of the recess in the breechblock and acting during the unlocking of the block under the shoulder of the firing pin (S) against the spring (S^i) secured to it.

U, a sear bolt projecting horizontally through the left side of the retractor box (I), and engaging in recess in firing pin (S) (which its end encircles) when in cocked position. The sear bolt is pressed from the center of the block by a coiled spring in the sear-bolt case.

V, a trigger pivoted in the trigger case, which is secured to the breech face at left of the bore. When the breech is closed the trigger nose (V^i) is in line with the end of the sear bolt (U), and the pulling of the trigger causes this nose to press the sear bolt against its spring so as to release the firing pin (S). The trigger plate is slotted vertically on the side toward the gun to form a guide and socket for the safety bolt (W).

W, a safety bolt, having a stud (W^i) at its upper end, and passing through the guide slot in the trigger plate. It is perforated to receive the screws of the latter, which control it. This bolt is notched transversely to permit the passage of the trigger toe (V^{ii}), which can only occur when the breech is locked, and the bolt (W) lifted through the stud (W^i) by the locking lug (B^{ii}) on the crank (B).

X, a locking stud to receive the locking latch (Y) of the crank (B), and to bear a portion of the thrust transmitted through the crank by the face plate (F) from the breechblock in the turning effort.

Y, a locking latch pivoted in a slot in the crank (B) and acting by gravity to engage the catch on the locking stud (X) when breech is locked. Its downward projecting arm is to enable this latch to be lifted by the hand grasping the crank handle when about to open the breech.

Z, an open hook pivoted upon the breech face above the rack (C) for the purpose of hooking over the end of the rack to retain mechanism in open position when so desired.

The breech being closed (the gun having been discharged), to open the breech grasp the handle (B^i) of the crank (B) with the right hand, at the same time lifting the locking latch (Y) from its catch in the locking stud (X) by pressing against its downward projection with the back of the right hand. Then pull the crank around, through an angle of 274°.

All the movements necessary to unlock the breechblock, to withdraw it into the tray or carrier, to swing the whole clear of the line of bore of the gun, to loosen and to eject the empty cartridge case, and to set the firing pin for the next discharge are effected in this one movement, in detail as follows: During the first 95° of revolution the crank pin (B^{iii}) opposite the handle (B^i) acts, through the rack link (D), to move the rack (C) to the left on the rack guide (E), by this means turning the block—through the corresponding teeth on the face plate (F)—through an arc of 60°, to unlock from the screw box of the gun.

During this movement the cocking cam (T), revolving with the block, pushes back the firing pin (S) until it is caught by the rear bolt (V), while the collar on the forward end of the breechblock being engaged with corresponding collar or projection (P^{ii}) on the forward end of the extractor plate (P_j, this plate is pulled back in its guides an amount

equal to the pitch of the breech screw for one-sixth of a revolution, and with it the empty cartridge case, the flange of which is embraced by the higher of the two projections (P^{i}) on the extractor plate. The case is thus loosened in the bore. During the succeeding 46° movement of the crank the breechblock is drawn from the gun in the tray (M), as follows: At the instant the block is unlocked the stud (B^{n}) on the crank comes into contact with the upper arm of the retractor (G) and draws it and its connections with the block back into the tray, the angular movement of the retractor accommodating itself to the parallel motion imposed upon the block by the guides of the tray (M) through the retractor link (K) and the bolts (J L). When the stud (B^{iv}) comes in contact with the retractor (G) the return bolt (H) is brought fairly under a hole drilled in the under side of the crank (B) near the pivot (B^{vi}). During the withdrawing motion this bolt is driven upward by the cam slot (A^{i}) and thus forms a connection between the retractor and the crank for the reverse movement. When the rearward motion of the block in the tray (M) is arrested by the shoulders of the latter the tray latch (N) is tripped from its stud (O) on the gun by being pressed down by the block (in the usual manner). Thereafter the further movement of the crank carries the whole mechanism around to the rear and side of the gun, where its momentum is utilized toward the end of its movement to eject the empty cartridge case by the sudden rearward motion imparted by it to the extractor plate (P), through the extractor lever (Q) and hook (Q^{i}), which engages in the slot (M^{i}) about the pivot sleeve of the tray (M). Before the termination of the motion of the mechanism the shoulder formed by the ending of this slot (M^{i}) catches the hook (Q^{i}) and carries it and its connections with it until the hook is automatically thrown out of connection with the slot shoulder, when extractor plate, lever, and hook are forced back to their normal positions by the spring (R^{i}). The mechanism may be retained in the "open" position, if desired, by turning down the open hook (Z) over the end of the rack (C).

The gun being reloaded, to close the breech move the crank back through the same angle. The block being locked in the tray (M) by the latch (N) and the crank (B) and retractor (G) being locked together by the return bolt (H), the mechanism as a whole is swung back to the breech face, the tray latch tripped, and the breechblock pushed to its seat with the teeth on the face plate (F) engaged with those of the rack (C) during the first 179°. When the block has reached its seat the return bolt (H) has been nearly withdrawn by the cam slot (A^{i}), and is only upheld by the spring encircling it, further movement of the crank driving it down by the action of inclined surface on its head, the resistance offered insuring the connection of the block thread with that in the gun. The remaining 95° moves the rack (C) to the right, revolving the block and locking it in the screw box, engaging the extractor collar (P^{ii}) of the plate (P) with that on the block, removing the cocking cam from under the shoulders of the firing pin, locking the crank to the gun by the locking latch (Y) catching upon the locking stud (X), and lifting the safety bolt (W) so as to allow the pulling of the trigger (V), the nose (V^{i}) of which having come fairly into line with the sear bolt (U) at the end of the revolution.

The crank itself forms the lock of the block when closed, as the locking lug (B^{ii}) bears against the locking stud (X) on the gun, while a shoulder on the crank takes the turning thrust transmitted through the face plate (F). The teeth of the rack and face plate are thus re-

lieved from this strain, their sole duty being the locking and unlocking of the breech screw.

The ready engagement and disengagement of the teeth of the face plate and rack is brought about by causing these operations to occur while the crank pin (B^{iii}) is passing its center, the retractor (G), on the contrary, being at the same time at full stroke in entering or withdrawing the block, so that its movement is accomplished while practically no motion is given to the rack by the rank link (D).

Respectfully submitted.

W. B. GORDON,
Captain, Ord. Dept., Inspector of Ordnance.

(5228–'92.)

SEABURY BREECH MECHANISM
for
5 INCH SIEGE RIFLE

Full Size
January 1891.

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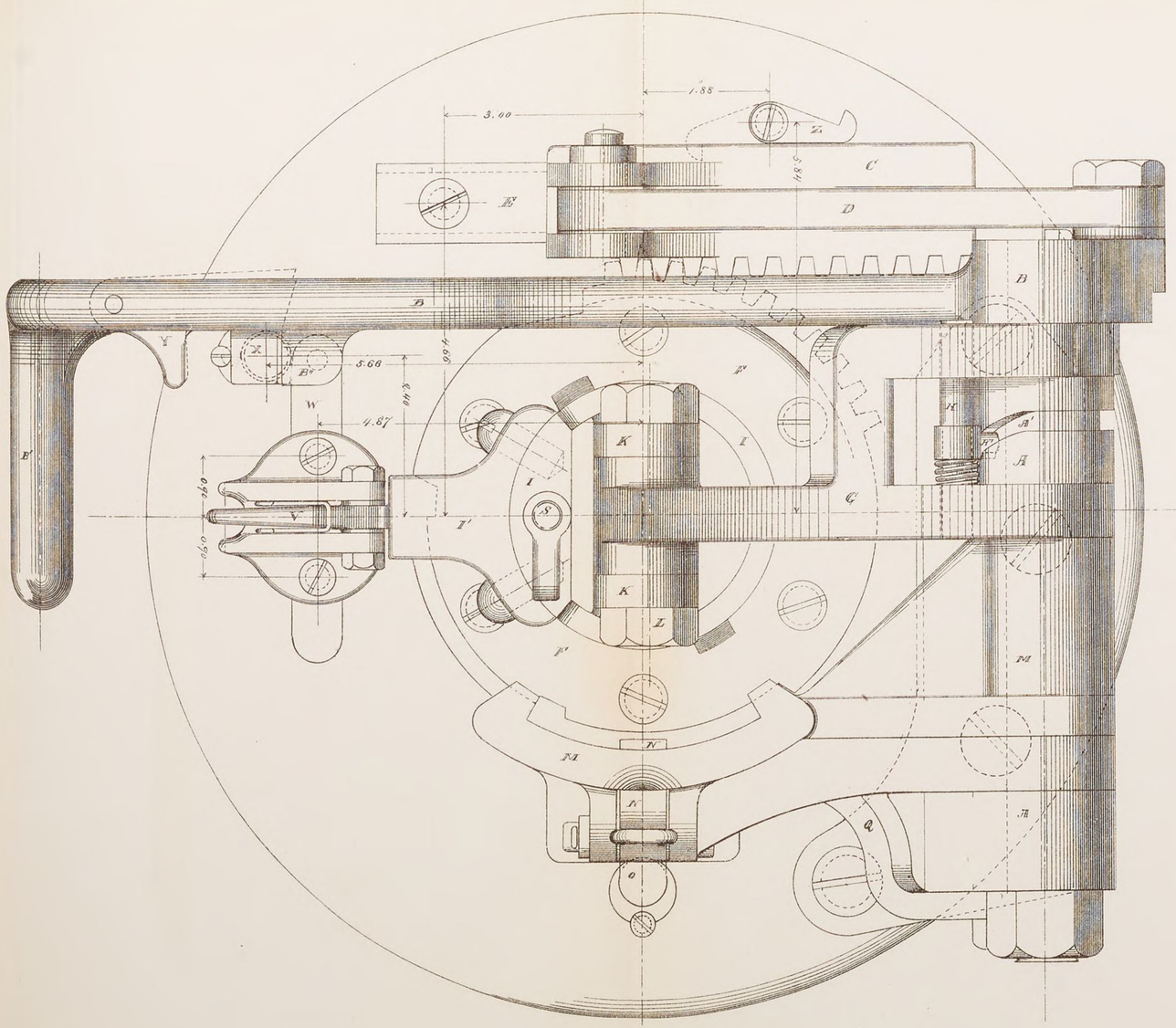
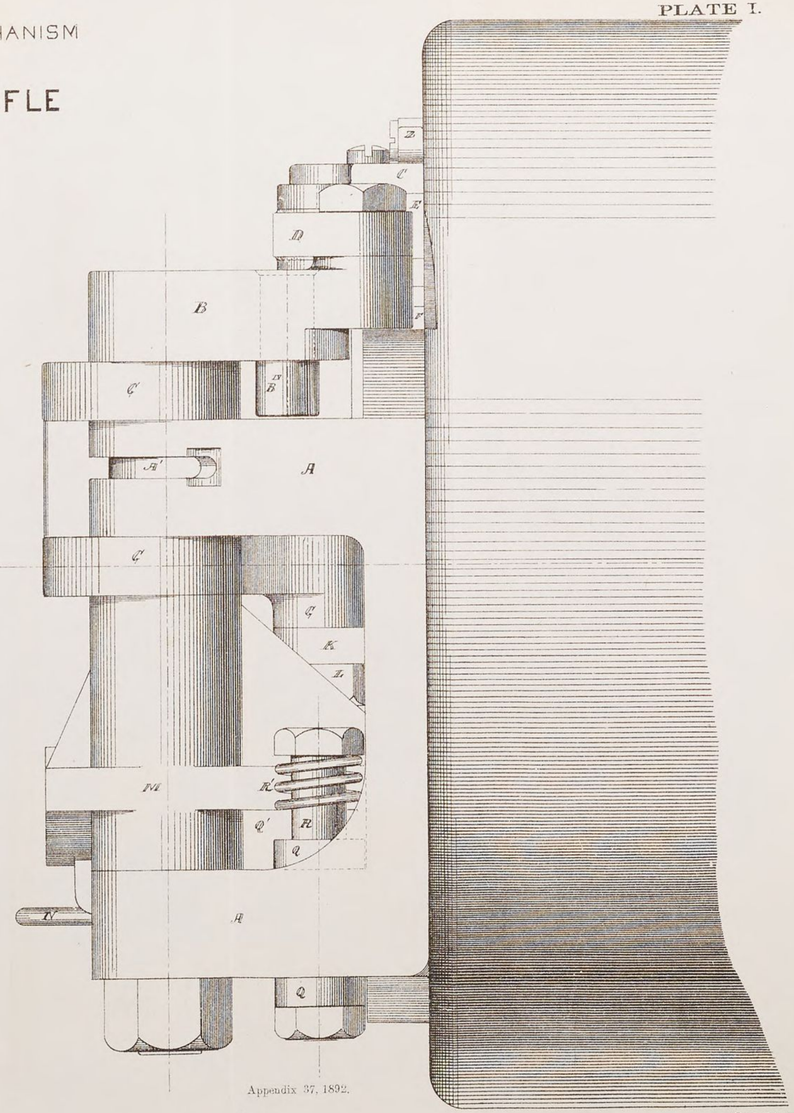
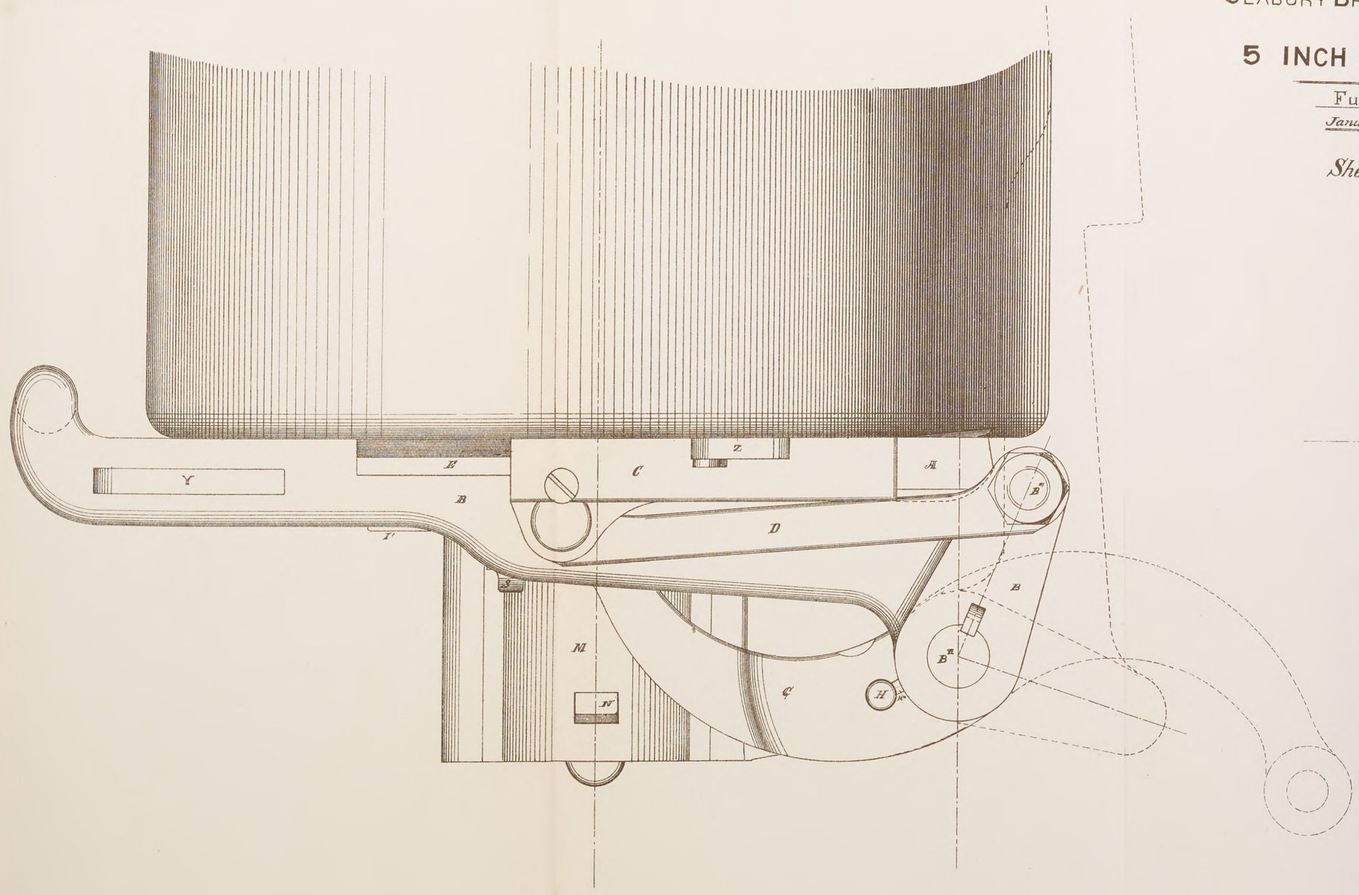


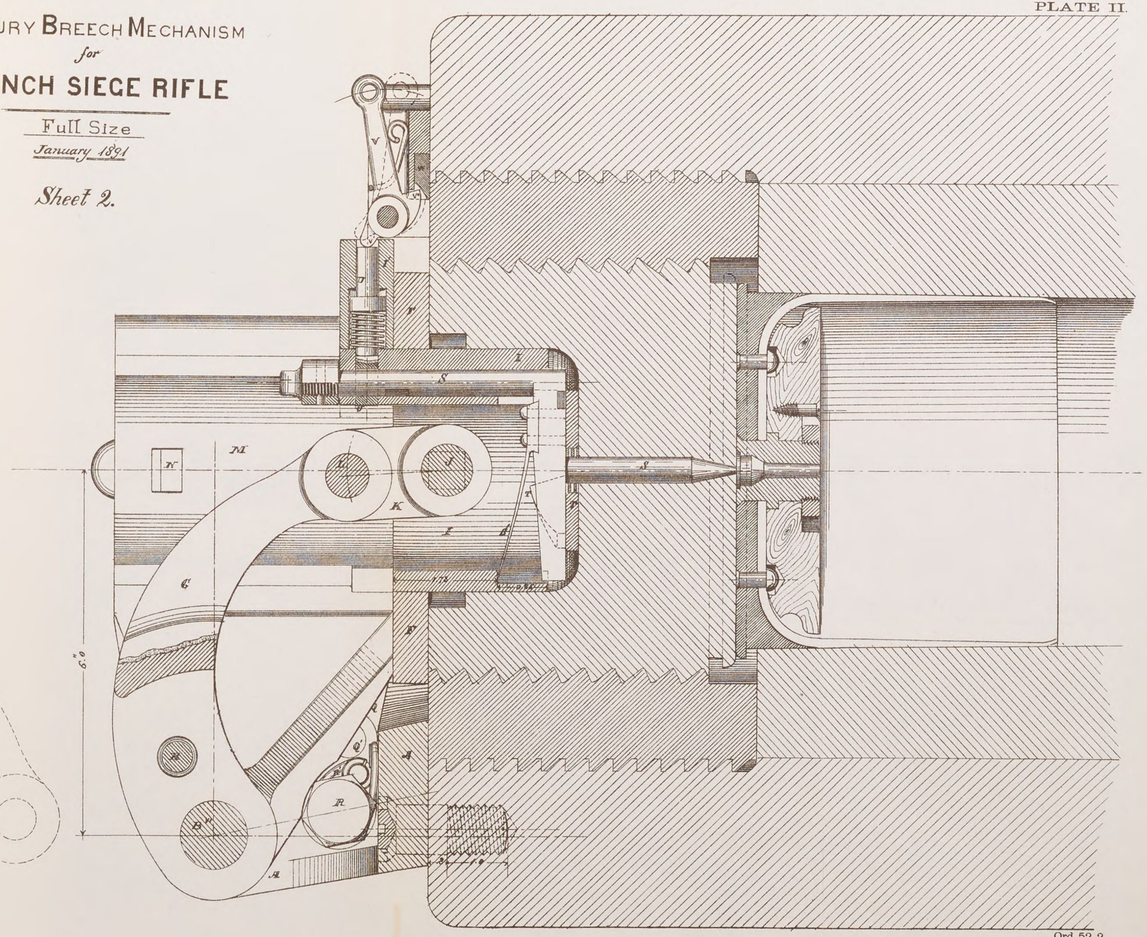


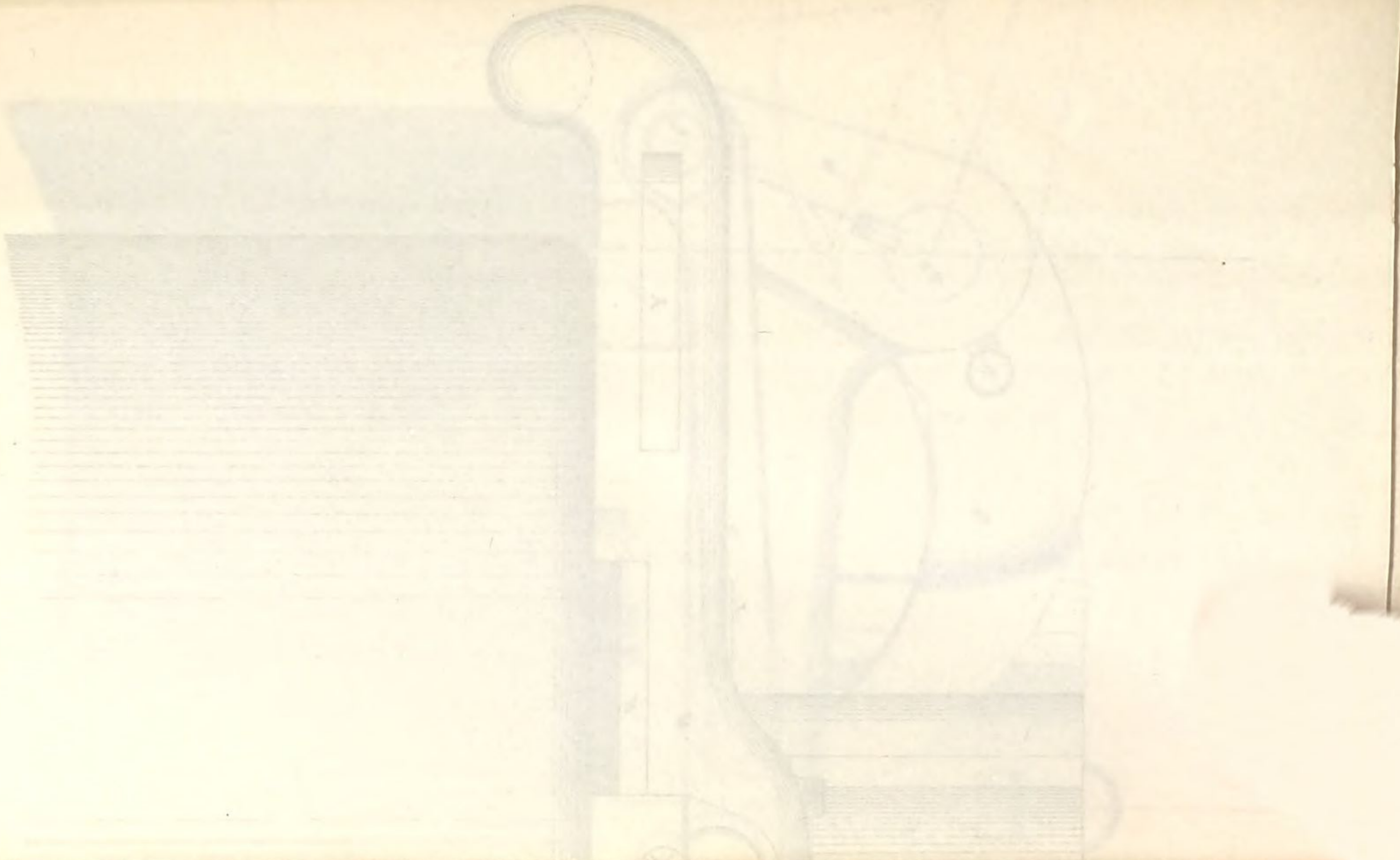
SEABURY BREECH MECHANISM
for
5 INCH SIEGE RIFLE

Full Size
January 1891

Sheet 2.



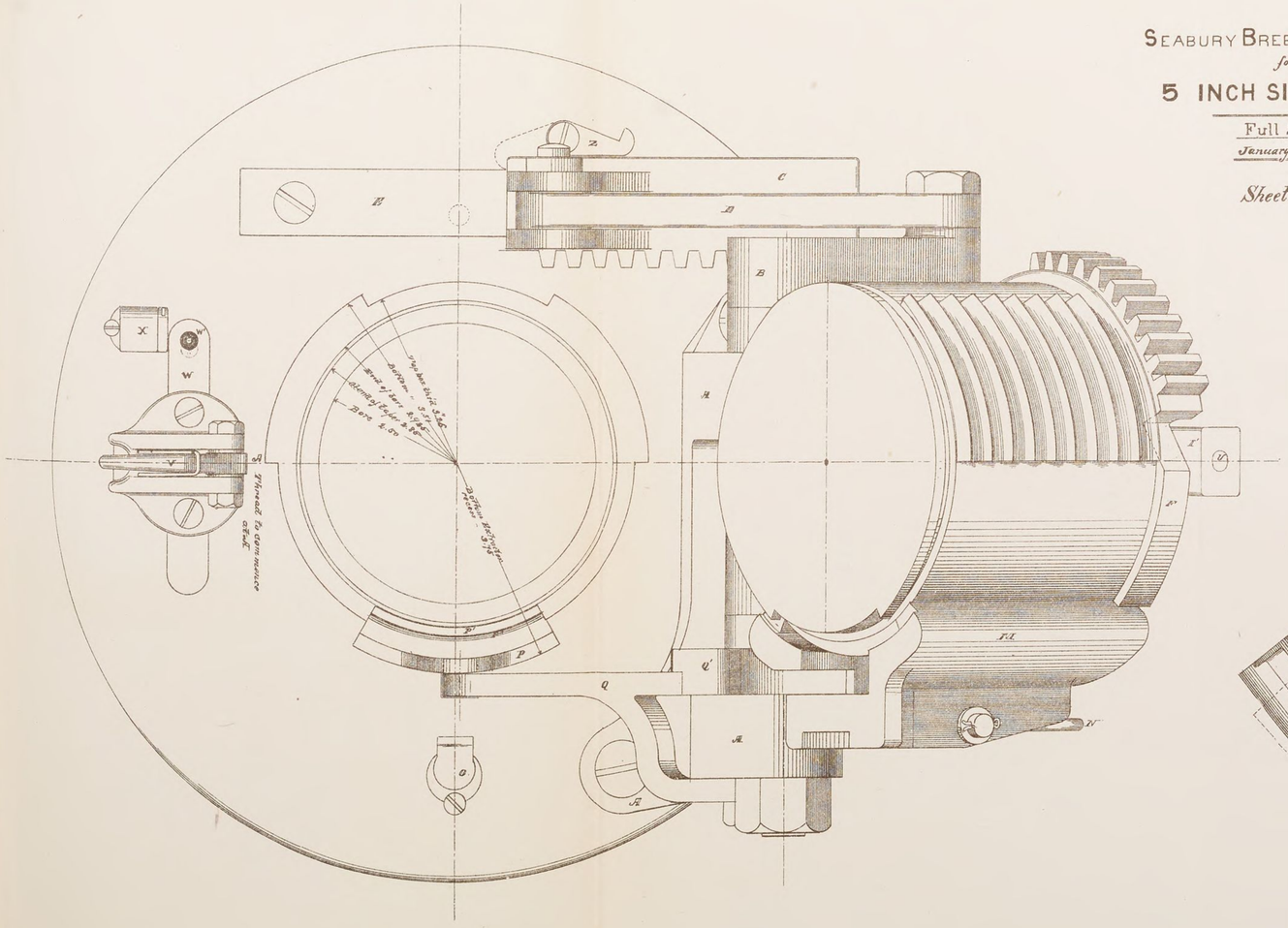


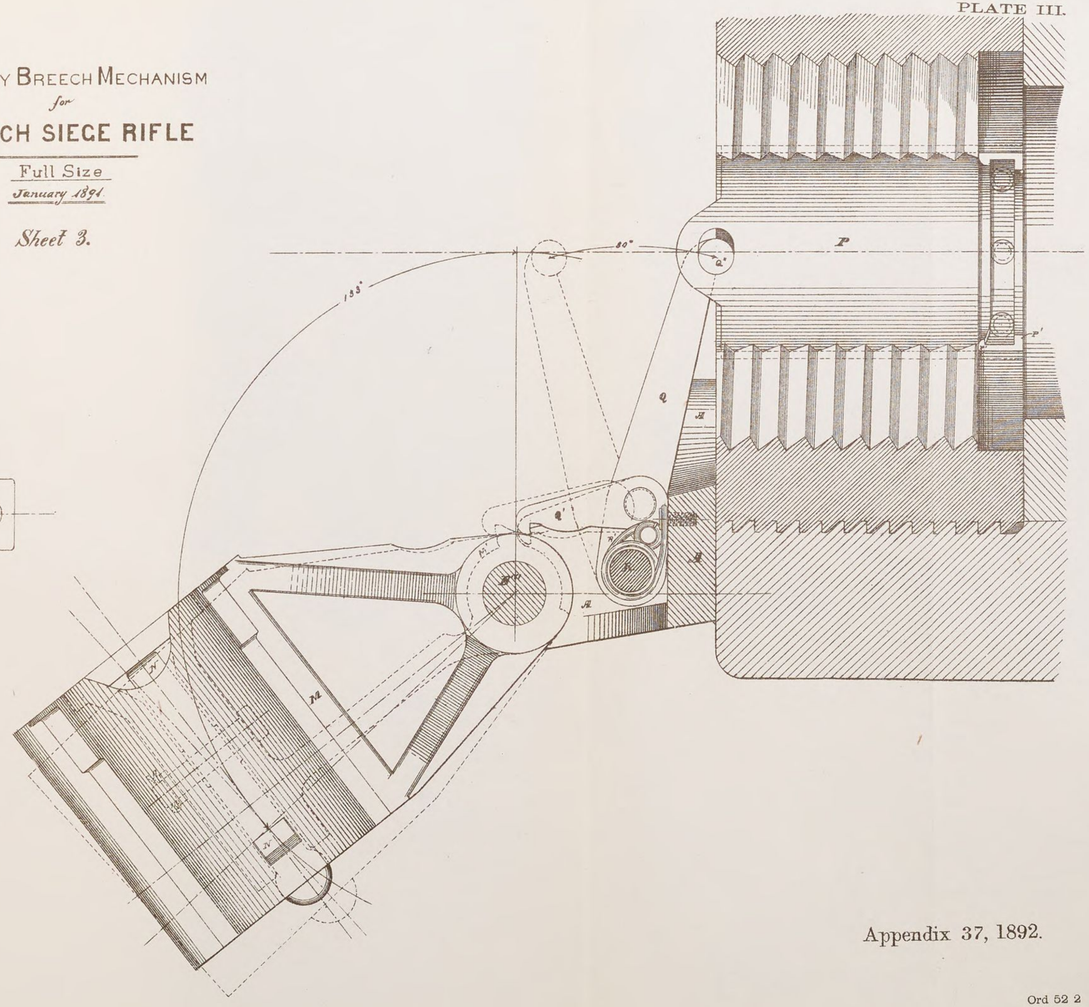


SEABURY BREECH MECHANISM
for
5 INCH SIEGE RIFLE

Full Size
January 1891

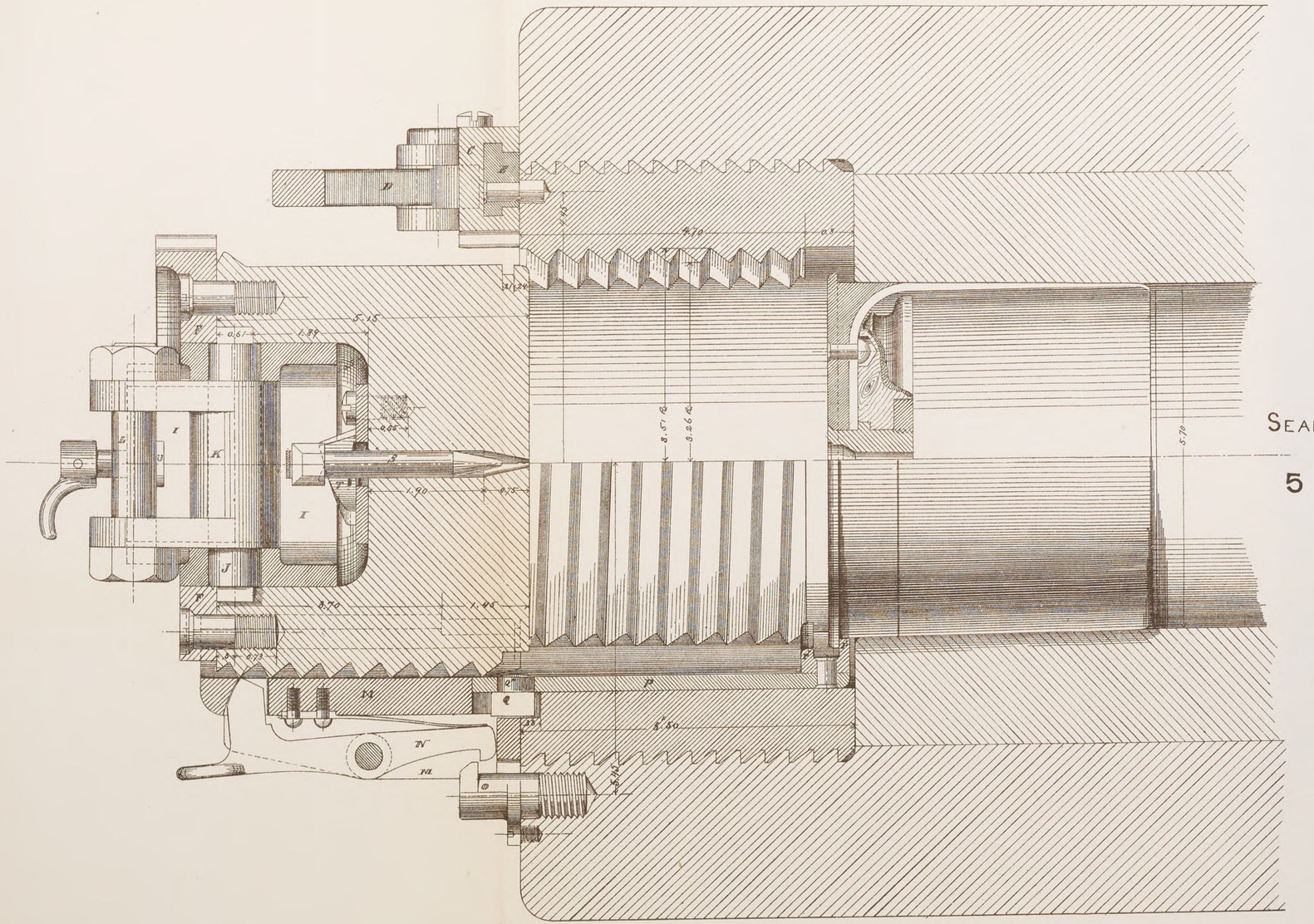
Sheet 3.





Appendix 37, 1892.

PLATE IV.

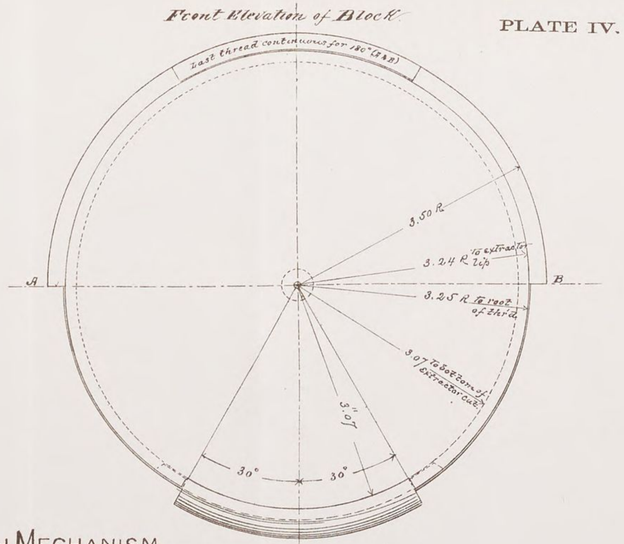


SEABURY BREECH MECHANISM
for
5 INCH SIEGE RIFLE

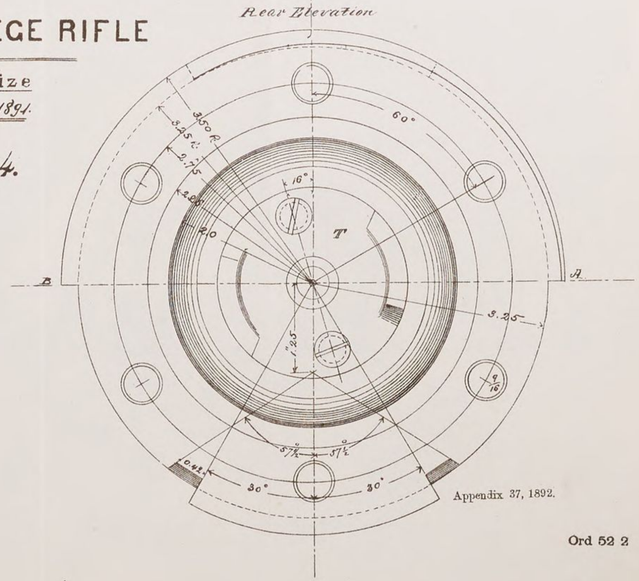
Full Size
January 1894.

Sheet 4.

Front Elevation of Block

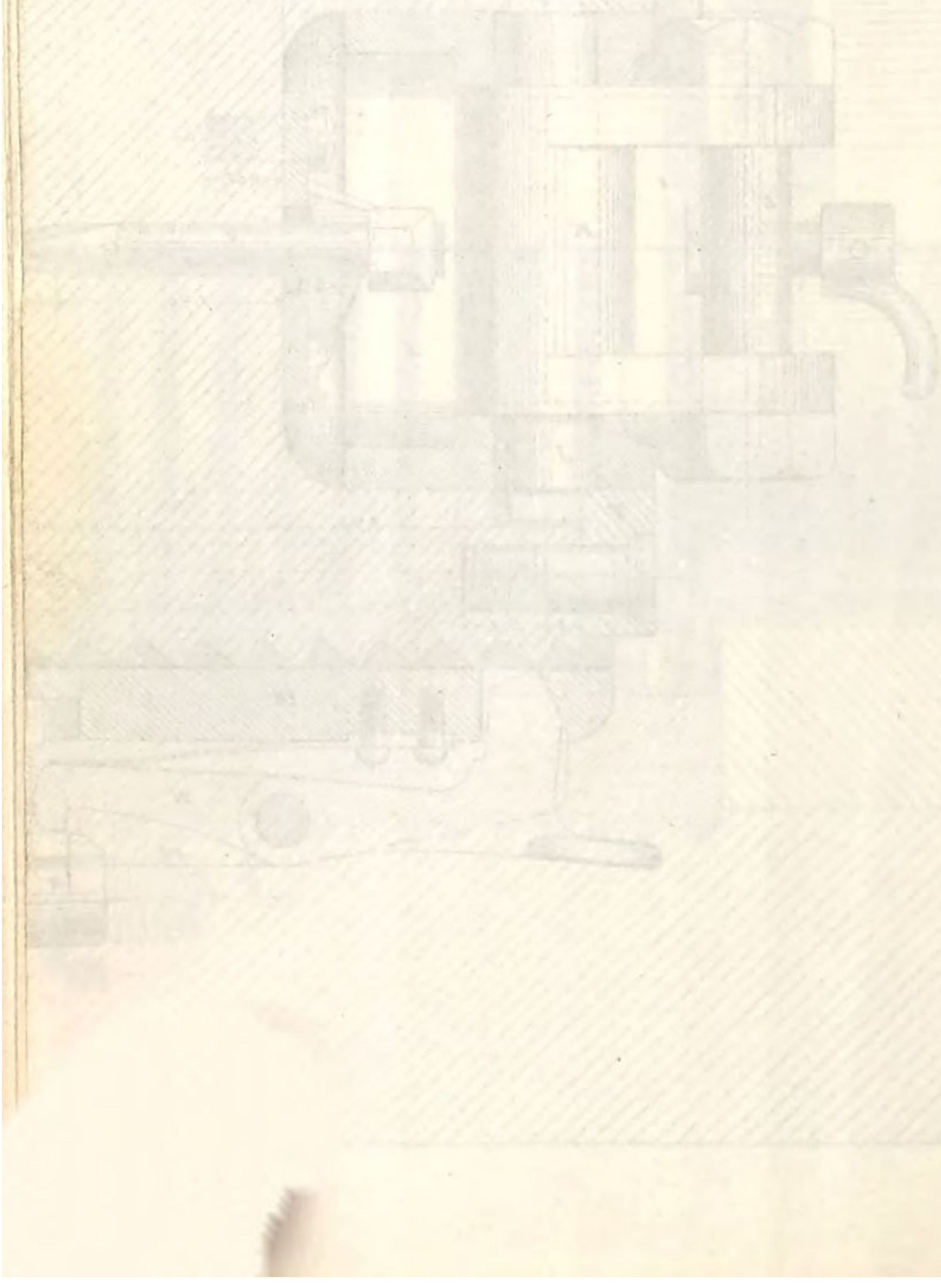


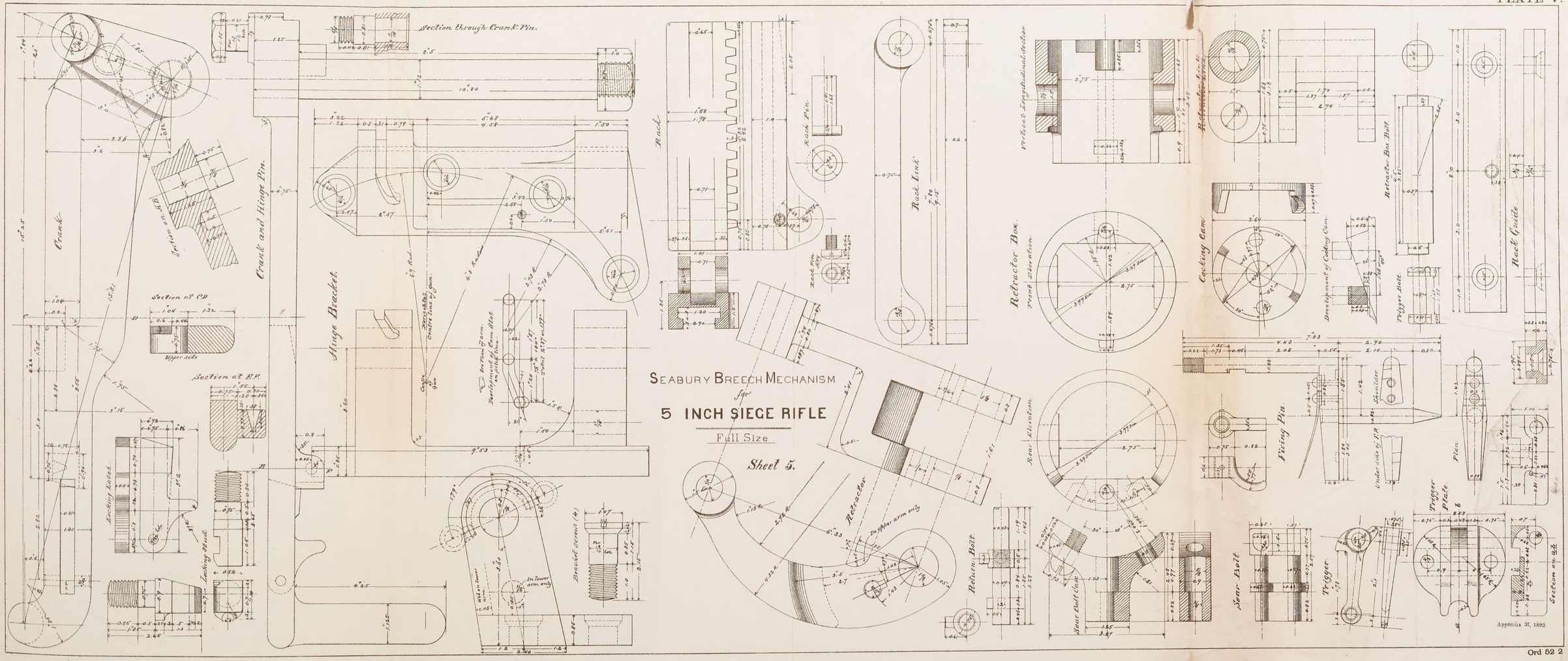
Rear Elevation



Appendix 37, 1892.

Ord 52 2

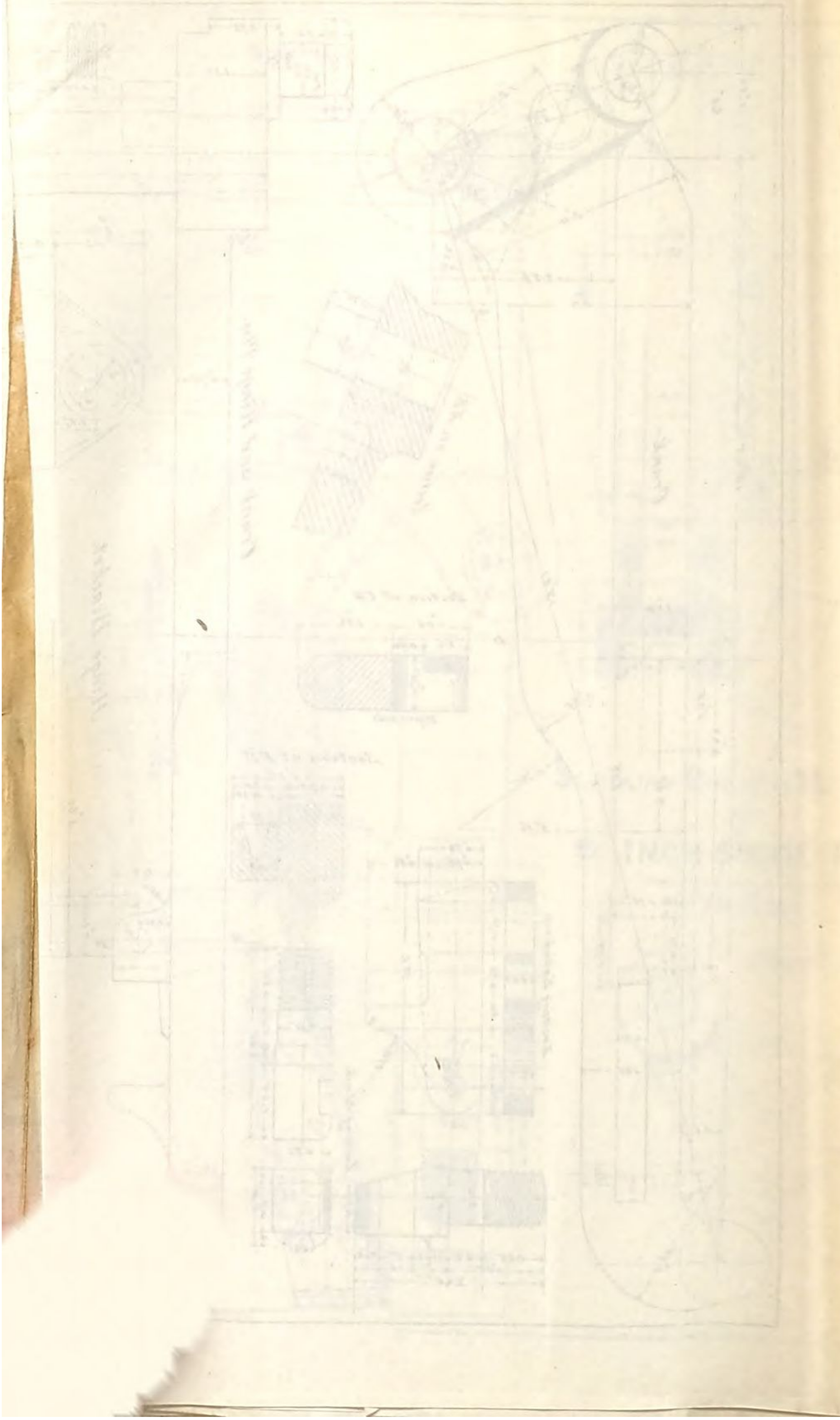




SEABURY BREECH MECHANISM
for
5 INCH SIEGE RIFLE
Full Size
Sheet 5.

Appendix 37, 1892

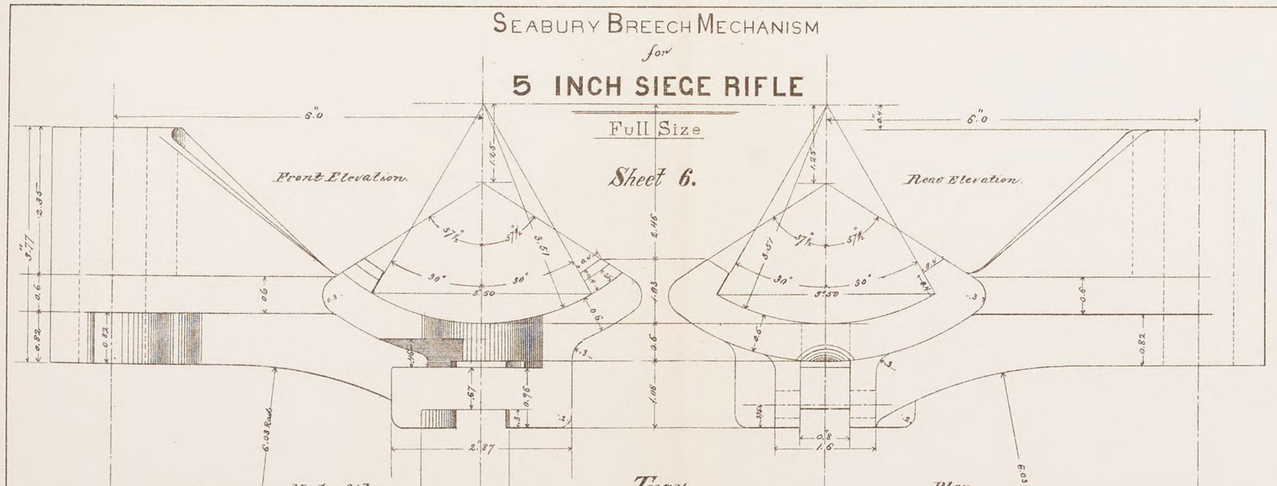
Ord 52 2

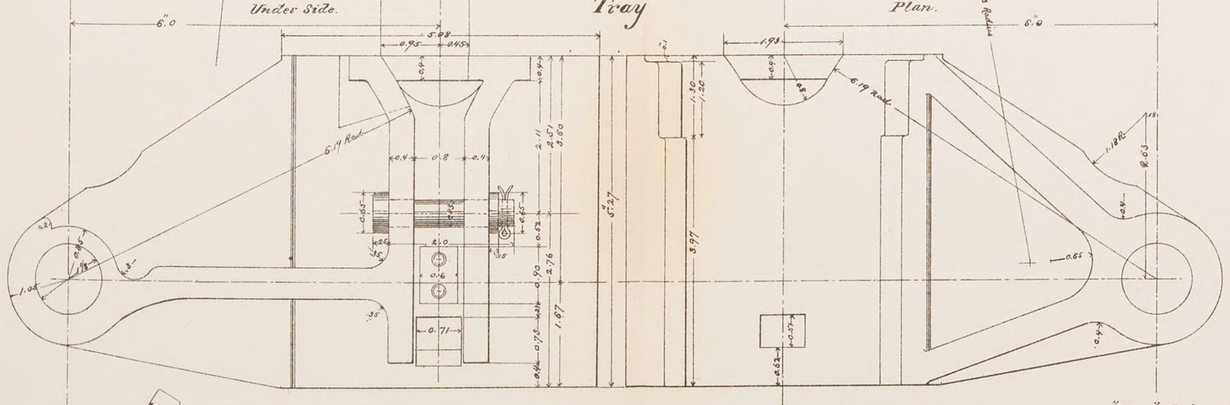


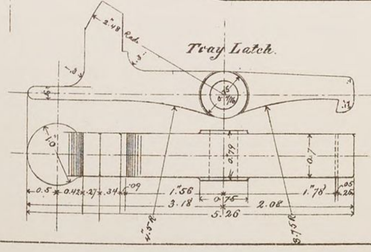
SEABURY BREECH MECHANISM
for
5 INCH SIEGE RIFLE

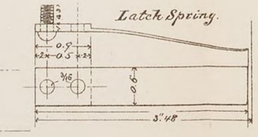
Full Size

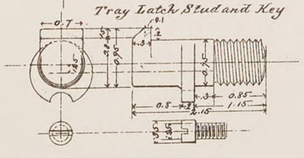
Sheet 6.

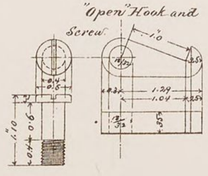


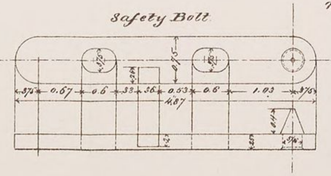


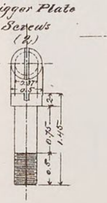


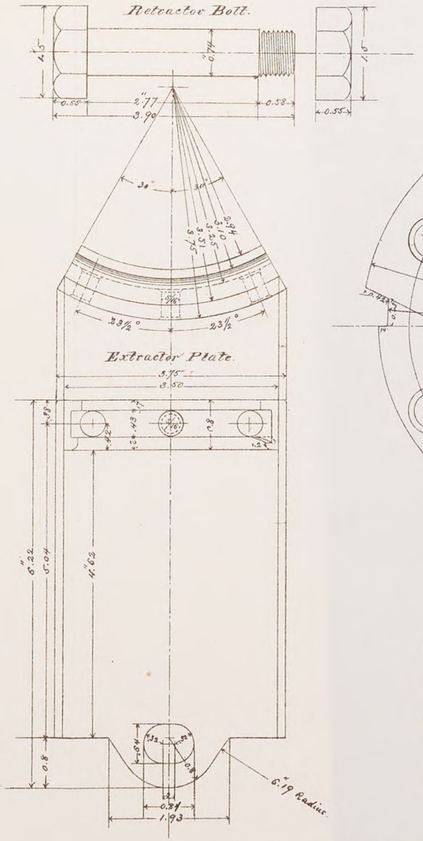


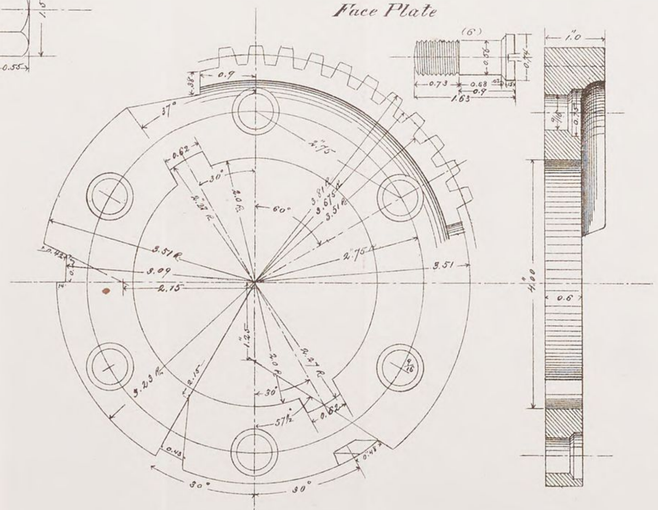


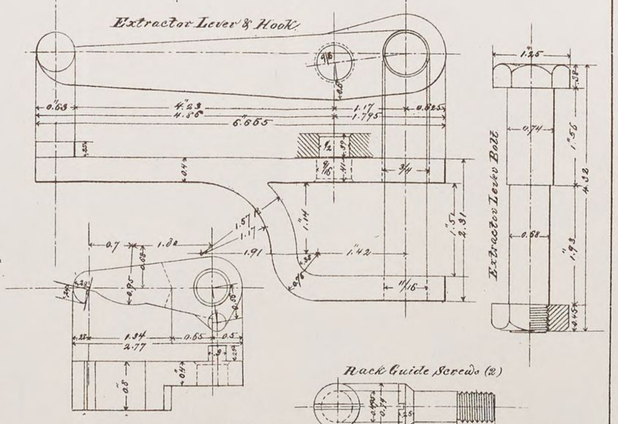


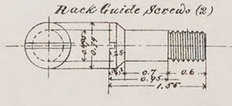










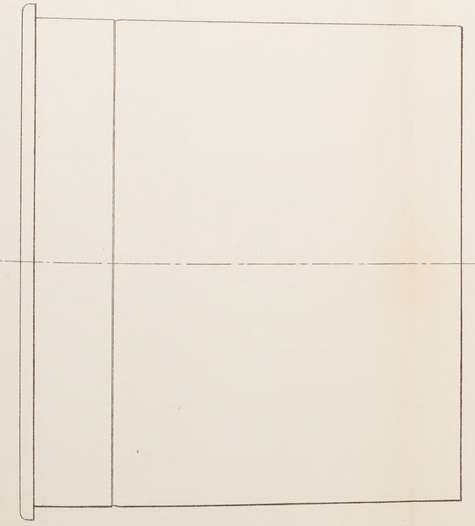


Appendix 37, 1892.

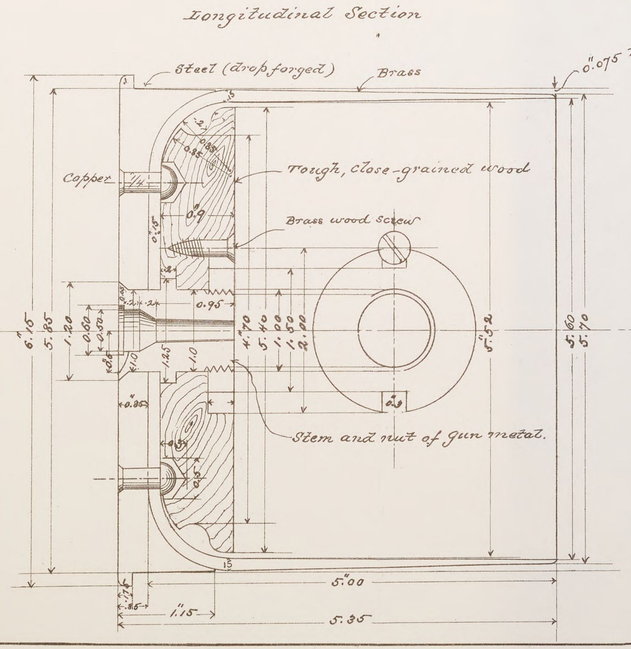
Metallic Base Cartridge for 5 Inch B.L.R.

Full size

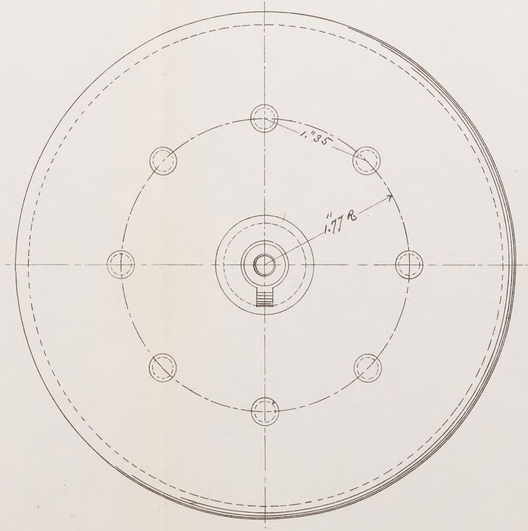
Elevation



Longitudinal Section

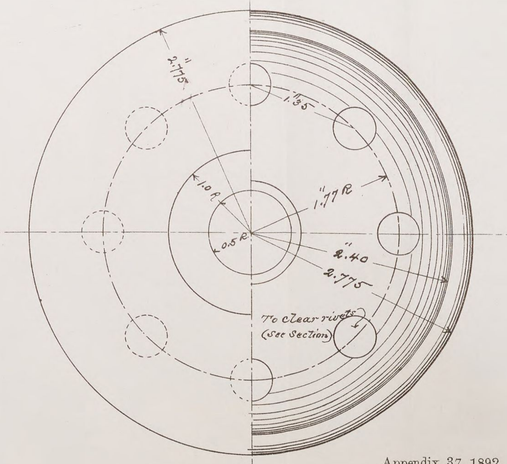


Base



Wood Disc

Front Face — Rear Face



Appendix 37, 1892.

— January 15th 1891 —

S.S.

Ord 62 2

APPENDIX 38.

DESIGN FOR 7-INCH B. L. SIEGE MORTAR, STEEL.

(2 plates.)

The mortar is intended to fill the existing need in the service of a piece for vertical fire in siege operations against strongly intrenched and covered positions. The siege artillery will then comprise the 5-inch B. L. rifle, 7-inch B. L. howitzer, and 7-inch B. L. mortar, all made of forged, oil-tempered, and annealed steel. The howitzer and the mortar are adapted to use the same projectiles.

The principal steel forgings for the mortar comprise the body, breech-block, spindle, gas-check cups, and carrier rings, having an aggregate weight of 2,200 pounds, nearly. The physical qualities are the standard prescribed by the specifications of 1891 for cannon of this caliber, the body in this respect being regarded as a jacket for which the minimum requirements are, elastic limit 46,000 and tensile strength 86,000 per square inch, with an elongation of 16 per cent on a specimen of 3 inches length.

The construction of the mortar is shown in detail in the accompanying drawings. The service required of the siege mortar is to deliver a relatively heavy projectile, at short or moderate ranges, to supplement the curved fire of the howitzer by vertical fire at medium ranges and to cover the field at shorter ranges which are inaccessible to the fire of the howitzer. Coupled with the limitations of weight and force of recoil, the characteristics of the rifled siege mortar as developed in recent years under these requirements embody a low powder pressure, a heavy projectile with low velocity, and a short piece not exceeding about 7 calibers in length of bore. A suitable maximum powder charge, taken with a given weight of projectile, is found in one that will give the initial velocity required to attain the desired range in connection with a chamber pressure not exceeding about 18,000 pounds.

The present mortar has a bore of 7-caliber length, the projectile of normal weight is fixed at 125 pounds, and the maximum service charge 5.5 pounds of I. B. sphero-hexagonal powder, giving a density of loading equal to 0.833. The relative weights of piece and projectile are nearly as 13 to 1, and of projectile and powder charge as 23 to 1. Including the present common shell of the 7-inch howitzer, weighing 105 pounds, and a long steel shell charged with high explosive, weighing 150 pounds, as intended for the mortar, the following initial velocities and maximum ranges are anticipated under a powder pressure not exceeding 18,000 pounds, viz:

Projectile.	Initial velocity.	Range.
Pounds.	*Feet secs.*	*Yards.*
105	730	4,340
125	685	4,040
150	640	3,670

Reduced charges of powder will enable the fire of the mortar to be made effective for ranges between about 650 yards and the maximum.

The body of the mortar is made of a steel forging with trunnions combined in a single piece, whereby a construction of satisfactory strength and minimum weight is best secured. Taking the elastic strength of the metal at a value $\theta = 45{,}000$, the elastic tangential resistance of the tube, estimated by the usual formula,

$$P = \frac{R^2_1 - R^2_0}{4R^2_1 + 2R^2_0,} 3\theta$$

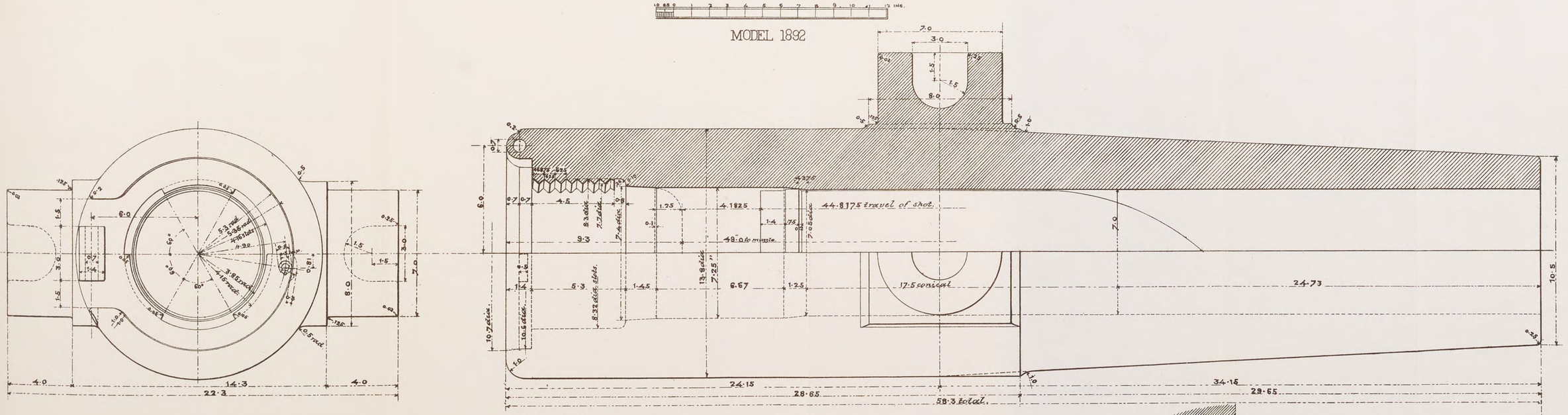
is 21,500 pounds in the chamber section and 15,340 pounds at the muzzle. The cross-sectional area of metal in the body at the front of breech recess is 2.3 times that of the powder chamber, making the factor of safety for the elastic longitudinal resistance approximately 5.

The breech mechanism is similar to that of the 3.6-inch field mortar, except the form of vent closer and gas check. With the larger caliber space is afforded for arranging a sliding instead of a swinging vent closer, and the De Bange system of obturation is used instead of the Freyre, in view of its adaptation to the construction of this piece. The principal points of difference between this mechanism and that of the field and siege guns are the substitution of fixed handles for the swinging lever of the latter and the arrangement for locking and unlocking the block. The locking is accomplished by a sheared pin set in the periphery of the block, which, on being partly turned when the block is closed, engages a portion of its full surface in bearing upon the end of a sector in the carrier ring. The action is that of a stay pin inserted in a hole made partly in each of two closely fitting cylinders to prevent the inner one from turning. The vent closer for the axial vent is operated by the motion of the locking pin to which a handle for turning is attached. The features of this mechanism wherein it differs from that of the field and siege guns are intended to meet the requirements of firing exclusively at high angles of elevation; the action of the parts is equally well assured in any position of the piece, and for the deliberate fire of these pieces the separate motion required to turn the handle of the locking pin was found to be not objectionable in the trials of the 3.6-inch field mortar, where the mechanism was subjected to a severe test and rough usage incidental to the overturning of the piece and carriage in experimental firings.

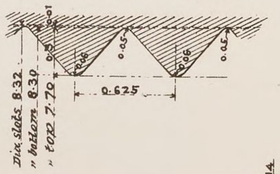
ORDNANCE OFFICE, WAR DEPARTMENT,
July 27, 1892.

7 INCH B.L. MORTAR.—STEEL, 1715 LBS.

MODEL 1892

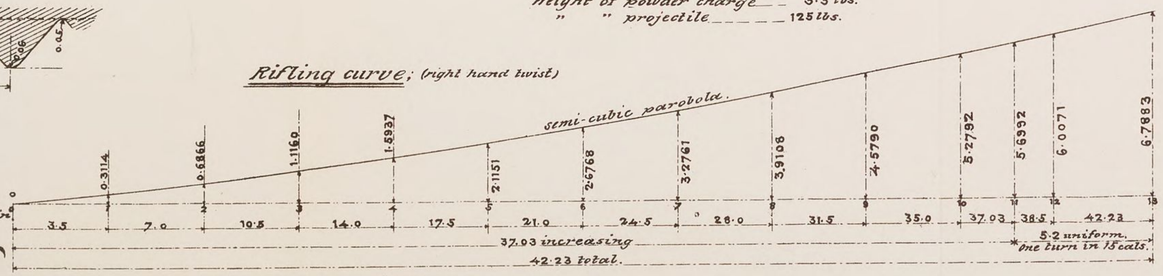


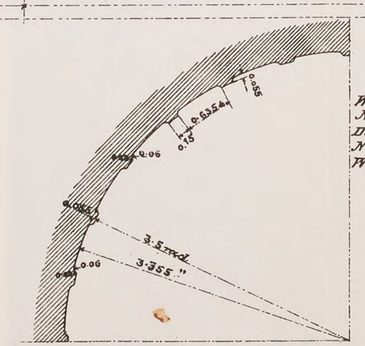
Detail of thread.



Volume of powder chamber ___ 182.8 cu. ins.
Density of loading _____ 0.833
Weight of powder charge ___ 5.5 lbs.
" " projectile _____ 125 lbs.

Rifling curve; (right hand twist)





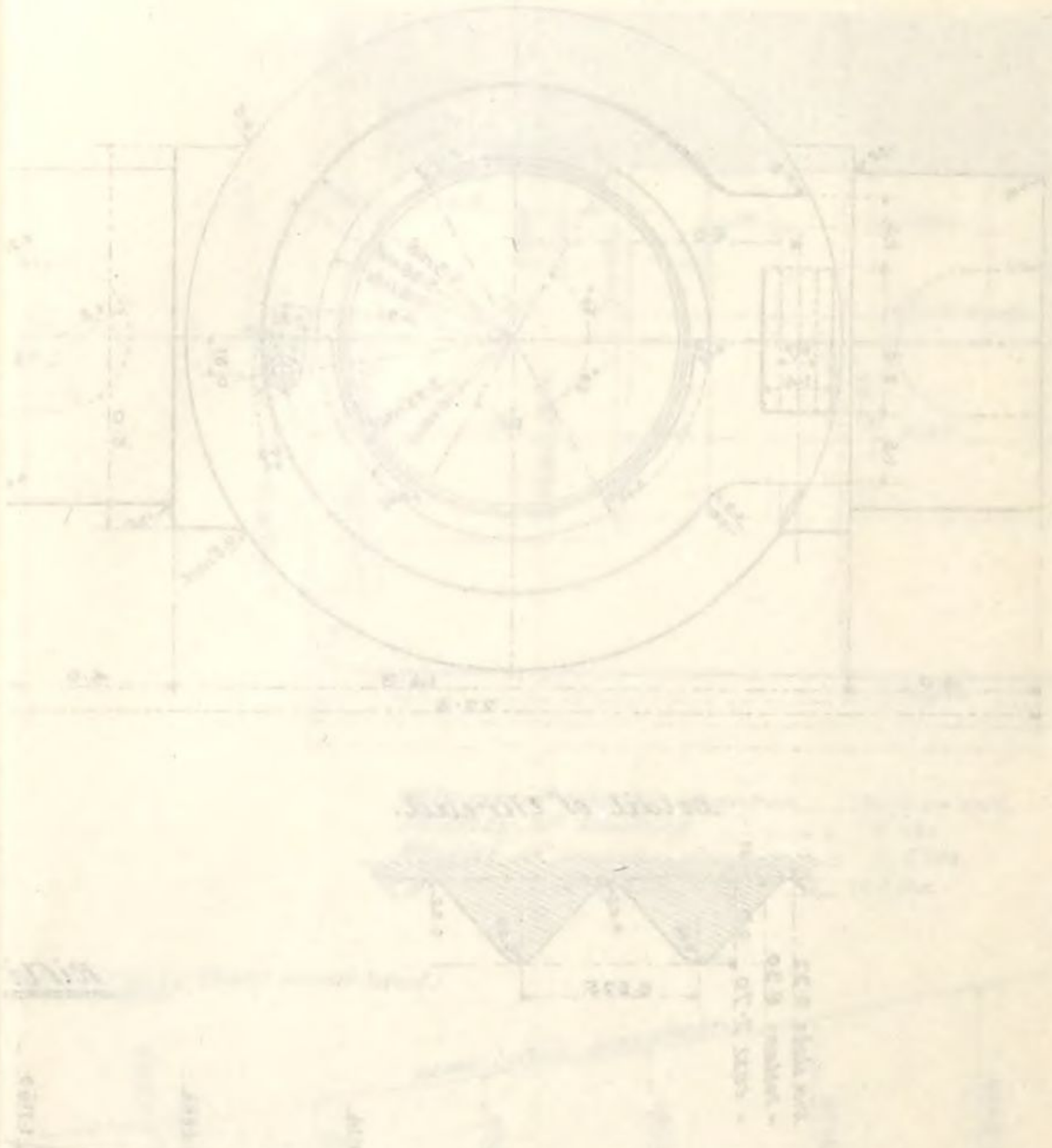
Rifling; { One turn in 40 cals. at origin increasing to one turn in 15 cals. at 5.2 ins. From muzzle, thence uniform.

Width of grooves _____ 0.6354
No. of grooves _____ 28
Depth " _____ 0.055
No. of lands _____ 28
Width " _____ 0.15

Approved:
D. D. Flagler
Brigadier General,
Chief of Ordnance.

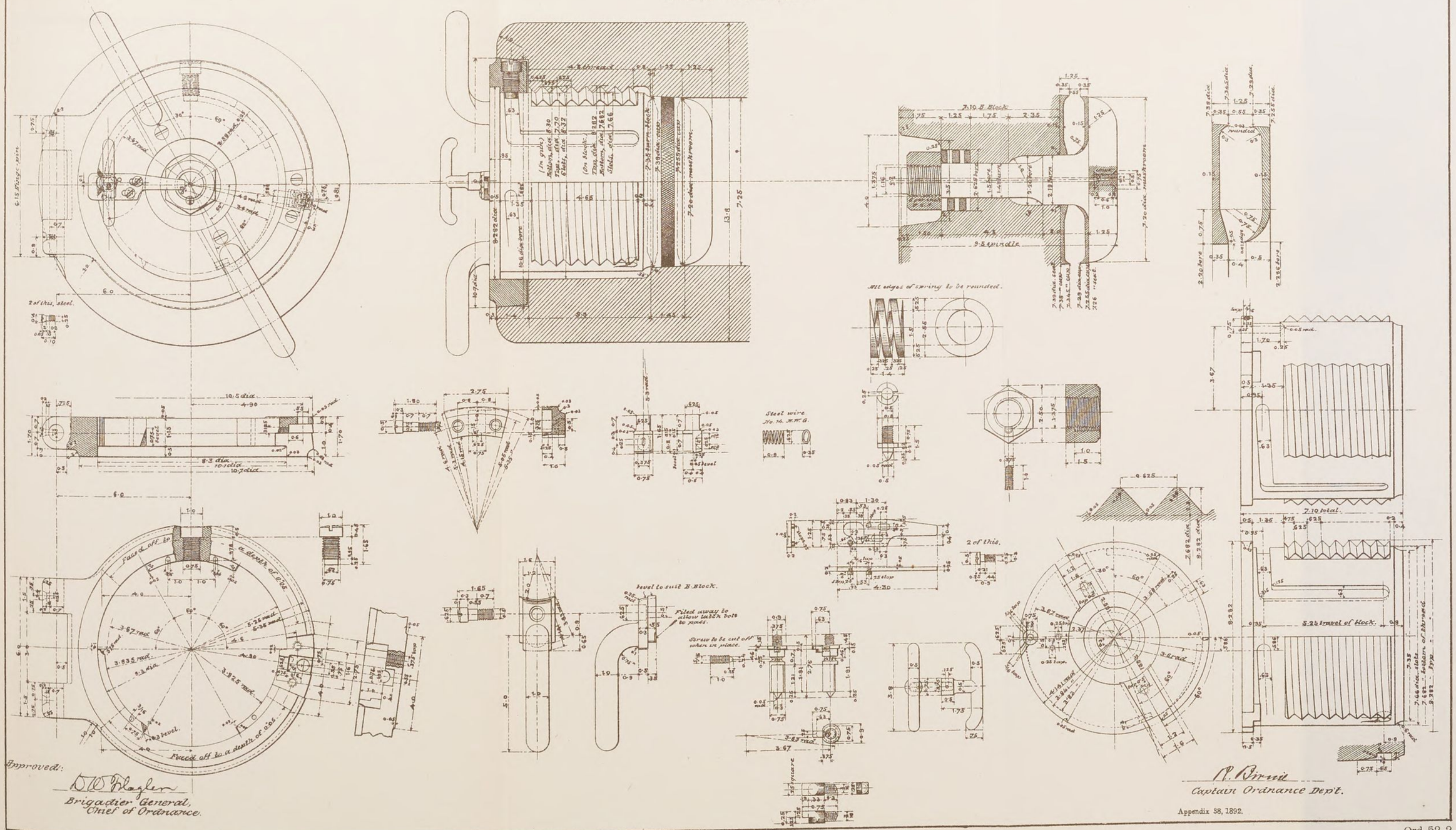
P. Birnie
Captain Ordnance Dept.

Appendix 38, 1892.



7 INCH B.L. MORTAR.—STEEL.

Breech Mechanism.



Appendix 38, 1892.

APPENDIX 39.

TEST OF 12-INCH B. L. MORTAR, CAST IRON, HOOPED WITH STEEL, NO. 1 TYPE.

REPORT BY THE BOARD FOR TESTING RIFLED CANNON, ETC., APPOINTED UNDER THE ACT OF CONGRESS, APPROVED JULY 5, 1884.

The cast-iron, steel-hooped 12-inch B. L. mortar, No. 1, South Boston Iron Works, the test of which is here reported upon, is a type piece representing seventy-three mortars, now constructed or in the process of construction. The sole particular in which it differs from these mortars is the rifling, which, in the piece under consideration, has a uniform twist of 1 turn in 35 calibers, while in the other mortars the twist increases from 1 turn in 45 to 1 turn in 25 calibers. In order to determine the effect of this change in the rifling on the accuracy of the piece the 12-inch cast-iron, steel-hooped, muzzle-loading mortar was converted into a 12.2-inch breech-loading piece, and rifled with the increasing twist noted above. In the report of the accuracy tests, following, those made with the 12.2-inch mortar are therefore included. The 12-inch muzzle loading mortar was fired 403 rounds before conversion. A report on these firings was made by this board soon after their completion. Since conversion into a 12.2-inch breech-loader 71 rounds have been fired.

Those fired in tests for accuracy are included in this report. All other firings referred to were from the 12-inch breech-loading mortar.

DESCRIPTION OF THE PIECE.

A description of the cast-iron, steel-hooped 12-inch B. L. mortar, No. 1, South Boston Iron Works, will be found in Appendix 22, Report of Chief of Ordnance, U. S. Army, for 1887.

FIRINGS.

The mortar has at the present date been fired 364 times, with charges of powder varying between 15 and 82 pounds and projectiles varying in weight between 619 and 635 pounds.

CARRIAGES.

Two hundred and fifty-one rounds were fired from the piece mounted on the modified Krupp experimental carriage. The remaining rounds have been fired from the Easton and Anderson spring return carriage, in the test of the carriage.

As the board has before it for consideration the piece only, mention is not made in this report of the action of either of the carriages or of the happenings thereto.

POWDERS.

In the various tests that have been made in this mortar numerous powders have been used. The following table sets forth the ballistic properties of the powders used in the principal tests. The powders are all of Du Pont's manufacture:

Kind.	Density.	No. of rounds.	Charge.	Mean instrumental velocity.	Mean pressure.
			Pounds.		
R. H. brown prismatic	1.825	1	65	996	18,300
		2	70	1,041	20,837
		2	72	1,061	22,250
		1	37	708	*9,000
		2	80	1,146	27,112
R. H. A. brown prismatic	1.830	2	74	1,124	27,075
		2	72	1,104	26,750
R. H. B. brown prismatic, lot 1	1.830	1	74	1,088	24,800
		2	80	1,163	28,500
		2	82	1,189	30,699
R. O. A. black prismatic	1.828	2	32	708	9,600
		2	63	1,060	27,000
R. O. B black prismatic	1.810	3	58	1,036	27,117
O. X. C. sphero-hexagonal, granulation 100	1.795	1	55	958	20,813
		2	65	1,051	26,650
M. W. hexagonal	1.725	2	25	636	8,800
L. X. B. square granulation 270	1.796	2	25	646	12,567
		1	15	484	.....

*Less than.

PROJECTILES.

The projectiles used in the tests were cast-iron shell, some provided with rotating bands only, others with both rotating and steadying bands. In the different firings the weights of the shell varied between 619 and 635 pounds. A greater number of shots having been fired with shell weighing 627 and 630 pounds than with shell of other weights.

RANGE.

The table exhibits the results of the tests for range.

No. of rounds.	Charge.	Weight of shell.	Elevation.	Mean range.	Mean deviation to right of plane of fire.	Wind.	
						Direction.	Force per hour.
		Pounds.	°	*Yards.*	*Yards.*		*Miles.*
10	33 pounds O. X. B...	626	60	3,913.9	274.6	Left	6
2	65 pounds O. X. A...	625	75	4,233.5	190.0	Left	6
10	32 pounds R. O. A...	627	60	4,024.3	213.4	Front and right...	19
10	33 pounds O. X. B ...	627	60	3,906.0	228.0	Front and right...	6
8	80 pounds R. H.....	630	45	10,480.0	404.0	Rear	16
10	30 pounds R. O. B...	624	60	4,032.4	233.0	Right	9
2	30 pounds R. O. B...	630	60	4,070.5	203.5	Right	16

ACCURACY.

Comparative tests of the effect of the different systems of rifling on the accuracy of the piece were made with the 12.2-inch and the 12-inch mortars as follows:

Charge.	Weight of projectile.	Elevation.	Mean range.	Mean deviation from plane of fire.	Dispersion.		Mean deviation from center of impact.		Wind.	
					In range.	Lateral.	Longitudinal.	Lateral.	Direction.	Force.
12.2-inch mortar:	*Lbs.*	°	*Yards.*	*Yards.*						
37 pounds O. X. C..	684	60	3879.5	304.3	96.7	52.0	23.8	14.2		
75 pounds R. H. B..	669	45	9683.1	551.8	195.4	6.9	44.5	1.1	Left and right.	18
37 pounds R. O. B ..	663½	60	4532.0	18.8	66.0	19.0	21.0	4.0	Right.....	20
17 pounds M. W....	664½	60	1950.1	123.1	50.0	15.0	13.9	4.5	Right.....	14
12-inch mortar:										
33 pounds O. X. R ..	626	60	3913.9	274.6	117.0	28.0	34.9	9.0	Left	6
32 pounds R. O. A..	627	60	4024.3	213.4	134.0	27.0	32.6	6.2	Front and rear.	19
33 pounds O. X. B ..	627	60	3906.0	228.0	104.0	12.0	31.3	3.2	Front and rear.	6
30 pounds R. O. B ..	624	60	4032.4	233.0	101.0	9.5	22.8	2.8	Right.....	9
80 pounds R. H.....	630	45	1048.0	404.0	220.0	139.0	62.5	41.9	Rear.....	16

Each of the above tests, with the exception of the last one, consisted of 10 rounds; 8 rounds were fired in the last test.

RAPIDITY.

The only test for rapidity was made in connection with a test for accuracy with the 12.2-inch mortar. The test included 10 shots, the time of firing each being noted. The 10 rounds were fired in 2 hours and 30 minutes, averaging one shot in 15 minutes. Between the first and second shots, however, an interval of 23 minutes elapsed, while between the eighth and ninth 34½ minutes elapsed. As it does not appear on the record opposite any of these rounds that any difficulty was experienced in loading the piece or in working the carriage it may be assumed that these delays were due to extraneous causes and that they should not be considered. The average time then for 8 shots will be 11½ minutes per shot.

ENDURANCE.

In the firings from rounds 5 to 45 it is noted that the latch of the console did not hold console to breech, unless the latch were held in place by tying with wire or cord. This is found noted again at round 250.

Motion of the breechblock in closing and opening was easily accomplished by one man in the first 45 rounds. At round 67 these movements were accompanied with slight difficulty, which increased to round 70. The front gas-check cup of copper was then filed and the difficulty disappeared. From rounds 119 to 128 the block could be opened and closed only by the use of mallets, levers, and ropes. At the latter round the gas check was washed and oiled, and the turning of the block was then performed by one man. In several instances in the remainder of the tests note is made of difficulty in the movements of the block. In each case the difficulty was easily overcome. At round 97 the head of locking bolt in rotating crank was found upset. At round 114 the socket of translating roller was cracked by striking on the platform in

elevating, while at round 118 the crank handle of the roller was bent in a similar manner while raising the breech after firing, the roller having come unlocked at the discharge and made one rotation to the rear. Similar unlocking occurred also in rounds 184 and 185. Opposite round 227 the following remark appears on the record:

> Gun was fired without locking breechblock. Breechblock entered but not rotated. Vent shield was not on mortar at time, having never been in use. Block was blown out, tearing off hinge and console. Hoop A^7 was torn apart opposite the hinge before hinge pin broke. Block lost by being projected into the sea.

At round 251 the spindle of spring lock of console latch was found to be bent and breaking.

CONCLUSION.

The board concludes that this piece has shown satisfactory endurance, 364 rounds having been fired without material damage. The results of the accuracy tests in the 12-inch and 12.2-inch mortars show that the change in the rifling will serve to increase the accuracy of the piece. The rapidity test reported can not be considered as showing the maximum rapidity of firing for this piece, as the piece was mounted on the modified Krupp experimental carriage, which is difficult to traverse, and the test was taken in connection with a test for accuracy, which would introduce delays otherwise avoidable.

OPINION.

In the opinion of the board the cast-iron, steel-hooped 12-inch B. L. mortar has been "subjected to the proper test, including such rapid firing as a like gun would be likely to be subjected to in actual battle, for the determination of the endurance of the same," this to the satisfaction of the board, and in the opinion of the board pieces of this type, or pieces differing from this type in the twist of the rifling only, as described above, may safely be put to use in the Government service.

F. H. PARKER,
Lieut. Col., Ord. Dept., U. S. Army, President.
CLIFTON COMLY,
Major, Ordnance Department, U. S. Army.
J. W. REILLY,
Major, Ordnance Department, U. S. Army.
FRANK HEATH,
Captain, Ordnance Department, U. S. Army.
ORMOND M. LISSAK,
Lieutenant, Ord. Dept., U. S. Army, Recorder.

(3809–'92.)

APPENDIX 40.

TEST OF THE 3.6-INCH B. L. RIFLE (STEEL) NO. 1, WATERVLIET ARSENAL, BY THE BOARD FOR TESTING RIFLED CANNON, ETC., APPOINTED UNDER THE ACT OF CONGRESS, APPROVED JULY 5, 1884.

(10 plates.)

The 3.6-inch B. L. rifle (steel) No. 1 was turned over to this board, at the ordnance proving ground, Sandy Hook, N. J., for trial, in accordance with instructions of the Chief of Ordnance, U. S. Army, dated December 6, 1890.

A general description of the piece will be found in the report of the Chief of Ordnance, U. S. Army, for 1890 (Appendices 23 and 43), and in the record forwarded with this report.

TEST OF THE PIECE.

The board determined on the following for the test of this piece:

Test for endurance.

One thousand five hundred rounds with projectiles of 20 pounds weight, with muzzle velocities of not less than 1,550 feet seconds and pressures not to exceed 36,000 pounds.

Test for rapidity.

Three groups, of 20 rounds each.

Test for accuracy.

Nine targets, of 10 rounds each, 3 at each range, as follows: 1,000 yards, 1 mile, and 3,000 yards.

Supplementary test.

Upon the completion of the test for endurance originally prescribed by the board, impressions of the powder and shot chambers showed the injuries noted in the report after round 1779.

In order to determine whether the marks on the top of the powder chamber were erosions or whether they were caused by a crack in the metal of the tube, the board decided to continue the test of the piece for endurance for another hundred rounds.

FIRINGS.

Two hundred and nineteen rounds had been fired from the piece—principally in proving powder—before it came into the hands of the testing board. At this date 1909 rounds have been fired.

POWDERS.

The powders used in the tests of the piece were as follows:

Maker.	Designation.	Density.	Granulation.	Charge.	Mean of 5 rounds.	
					Velocity at 125 feet.	Pressure.
				Lbs. Oz.	*Ft. secs.*	*Lbs.*
Laflin & Rand	I. K., lot 1	1.710	2,560	4 12	15.36	35,214
Laflin & Rand	I. K., lot 7	1.725	2,571	4 12	15.31	34,268
Du Pont	U. F., lot 3, spherohexagonal.	1.700	123	4 6	15.26	35,648

Besides these powders many by both makers were proved in the piece and found unsatisfactory.

PROJECTILES.

The projectiles used throughout the tests were cast-iron shell with single copper band, and weighted with sand to 20 pounds.

RANGE AND ACCURACY.

The trials for range were made over the sea, and the fall of the shell observed by two observers at the ends of a base line 2,000 yards long. Tests were made at angles of elevation varying by 2° from 2° to 14°, inclusive. The following table embodies the results of these tests. The charge of powder was 4 pounds 12 ounces, Laflin & Rand's I. K., lot 1:

Elevation.	No. of shots.	Mean range.	Deviation from plane of fire.	Wind.	
				Direction.	Force.
°		*Yards.*	*Yards.*		*Miles.*
2	10	1,646	6.7 left	Front and right	5
4	10	2,555	8.1 left		
6	10	3,291	6.3 left		
8	10	4,021	4.4 left		
10	10	4,669	6.1 left		
12	11	5,227	16.1 right	Front and right	9
14	10	5,802	33.8 right		

The following table is a summary of the results obtained in the accuracy tests required by the board:

Range.	Powder charge.	Elevation.	Shots fired.	Hits.	Deviation from center of impact.			Wind.	
					Vertical.	Horizontal.	Mean.	Direction.	Force.
Yards.		° ′			*Feet.*	*Feet.*	*Feet.*		*Miles.*
1,000	Laflin & Rand's, I. K., lot 1, 4 pounds 12 ounces.	1 20	10	10	0.62	1.15	1.306	Left and rear	9
1,000		1 20	10	10	1.01	1.41	1.73	Left and rear	9
1,000		1 20	10	10	1.31	2.175	2.539	Left and rear	9
1,760		2 20	10	10	1.06	1.2	1.6	Rear	8
1,760		2 28	10	10	1.735	1.8	2.5	Left	22
1,760		2 32	10	10	2.95	1.425	3.276	Left	22
3,000		4 12	8	8	7.882	3.077	8.461	Not observed	10
3,000	Du Pont's spherohexagonal U. F., lot 3, 4 pounds 6 ounces.	4 39	5	4	1.25	2.25	2.57	Front and right .	4
3,000		5 25	5	5	4.32	0.64	4.36	Front and right .	6
3,000		5 25	10	10	4.45	2.56	5.13	Front and right .	6

NOTE.—In the tests made at the 3,000-yards range the Scott sight was used for the first two; the Frankford Arsenal sights for the remaining two.

RAPIDITY.

In the rapidity tests 10 rounds, Nos. 398 to 407, were fired in 8 minutes; 20 rounds, Nos. 916 to 935, were fired in 13 minutes; 8 rounds, Nos. 1595 to 1602, were fired in 3 minutes 45 seconds; 20 rounds, Nos. 1603 to 1622, were fired in 8 minutes.

ENDURANCE.

In rounds 1 to 14 slight difficulty in operating breechblock is noted. No further mention of this difficulty appears, except at round 787. At round 481 it was found that the left side of the recess in the carrier ring was badly burred by the edge of the cam of the lever handle. This defect was remedied by dovetailing a piece of steel into the side of the recess. The first piece being found too soft, it was replaced by harder steel. The edge of the cam was rounded off and case-hardened. These parts are now slightly burred. At round 636 the sleeve and ring were found to have separated 0.018 inch. At round 786 two copper washers were placed over the spindle of the mushroom head, and at round 792 an additional washer, the object of these being to tighten the spring on the spindle to assist in the withdrawal of the block. The vent was reamed out at round 837. The rear gas-check cup was smoothed with a file at round 905. At round 1136 a new vent was put in the piece. At round 1606 this vent was reamed out. One asbestus gas check was used throughout the first 1733 rounds and throughout efficiently closed the breech against escape of gas. It was worn down to a thickness of one-half inch from an original thickness of three-fourths of an inch, and was still hard and serviceable; it was then replaced by a new and thicker pad. Gutta-percha impressions of the bore of the piece taken after round 1779 showed a deep longitudinal score along the top of the chamber in front of the vent, and erosions of considerable depth from this point to the front of the chamber. The bottom threads for the vent bushing are partially destroyed, also the bottom threads of the vent bushing. The cone between the powder and shot chambers was still more deeply eroded, deep erosions also occurring at the beginning of the rifling. Impressions of the bore after

round 1791 showed no appreciable enlargement of score in front of vent. The development of a small score in top of powder chamber starting to rear from vent was observed. Impressions of the bore after round 1801 showed enlargement of score in front of vent, quite noticeable, and scoring at base of rifling much more marked. Small score in top of powder chamber in rear of vent noticeable. Impressions taken after rounds 1815 and 1825 showed no marked difference in erosions. Impressions taken after round 1853 showed a marked increase in depth of erosions at slope of powder chamber and at beginning of rifling. Impressions taken after round 1909 showed a noticeable increase in depth of erosions around vent, and very marked increase in depth of erosions at slope of powder chamber and beginning of rifling.

The table which follows shows the changes in the bore occasioned by firing 1713 rounds:

LANDS.

From muzzle.	Before firing.	After round 1713.	Enlargement.	From muzzle.	Before firing.	After round 1713.	Enlargement.
Inches.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inches.*	*Inch.*
0	3.602	3.6135	.0115	44	3.600	3.607	.0070
2	3.602	3.607	.0050	46	3.600	3.607	.0070
4	3.602	3.6075	.0055	48	3.600	3.6065	.0065
6	3.6025	3.608	.0055	50	3.600	3.6075	.0075
8	3.602	3.610	.0080	51	3.600	3.608	.0080
10	3.602	3.610	.0080	52	3.600	3.609	.0090
12	3.602	3.610	.0080	53	3.600	3.61	.0100
14	3.602	3.6065	.0045	54	3.600	3.612	.0120
16	3.602	3.609	.0070	55	3.600	3.6155	.0155
18	3.601	3.607	.0060	56	3.600	3.613	.0130
20	3.601	3.6055	.0045	57	3.600	3.613	.0130
22	3.601	3.605	.0040	58	3.600	3.614	.0140
24	3.601	3.604	.0030	59	3.600	3.6145	.0145
26	3.600	3.604	.0040	60	3.600	3.615	.0150
28	3.600	3.604	.0040	61	3.600	3.6155	.0155
30	3.600	3.604	.0040	62	3.600	3.6165	.0165
32	3.600	3.604	.0040	63	3.600	3.6165	.0165
34	3.600	3.6045	.0045	64	3,600	3.62	.0200
36	3.600	3.604	.0040	65	3.600	3.621	.0210
38	3.600	3.6045	.0045	66	3.600	3.625	.0250
40	3.600	3.605	.0050	67	3.600	3.632	.0320
42	3.600	3.606	.0060				

CHAMBER.

Vertical diameter.				Horizontal diameter.			
From breech.	Before firing.	After round 1713.	Enlargement.	From breech.	Before firing.	After round 1713.	Enlargement.
Inches.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inches.*	*Inch.*
10¾	3.900	3.902	.002	10¾	3.900	3.902	.002
11¾	3.900	3.902	.002	11¾	3.900	3.902	.002
12¾	3.900	3.902	.002	12¾	3.900	3.902	.002
13¾	3.900	3.9015	.0015	13¾	3.900	3.9015	.0015
14¾	3.900	3.900	.000	14¾	3.900	3.901	.001
15¾	3.900	3.899	.001	15¾	3.900	3.902	.002
16¾	3.900	----------	----------	16¾	3.900	3.902	.002
17¾	3.900	3.900	.000	17¾	3.900	3.902	.002
18¾	3.900	3.901	.001	18¾	3.900	3.901	.001
19¾	3.900	3.903	.003	19¾	3.900	3.9015	.0015
20¾	3.900	3.9025	.0025	20¾	3.900	3.902	.002
21¾	3.900	3.905	.005	21¾	3.900	3.903	.003

CARRIAGE.

The piece has been fired from a steel field carriage, Buffington No. 4, originally supplied with spiral-spring brakes with clevis attachment. It was soon discovered that the cap squares of the carriage were not heavy enough for this gun, and that they were bent by each discharge. After round 15 the carriage was sent to the National Armory, where it was fitted with heavier cap squares and new chin bolts and keys.

Throughout the firings weaknesses were developed in numerous parts of the carriage, as will be seen by reference to the attached record. The brakes were frequently broken and more frequently jumped off the wheels during recoil. Bolts and nuts were constantly loosened by the firing; the plates of the flask separated slightly; one of the cannoneer's seats was cracked; the elevating gear needed frequent repairs; in short the carriage was generally racked and strained beyond its strength. It is manifest that it has not sufficient strength for use with this gun.

RECOMMENDATIONS.

The board recommends that the left side of the recess in the carrier ring and the cam of the lever handle be so hardened as to remedy the defect noted in the paragraph on endurance. The board believes that the scores radiating from the vent are due principally to the erosion of the vent bushing itself, and recommends that in pieces of this type the vent bushings be carefully watched and that they be replaced by new bushings as soon as any wear in them is apparent.

The board calls attention to the notes in the record opposite rounds 424 and 440, and frequently afterwards, that the cartridges would not enter the chamber, the cartridge bags being too large.

CONCLUSION.

The board concludes that the piece has shown satisfactory endurance (1909 rounds), of which 1600 were with full charges, as prescribed by the board, having been fired without material damage beyond that to the recess in the carrier ring and to the cam of the lever handle, as well as the erosions in the shot and powder chambers and at the beginning of the rifling as noted above.

In the determination of the endurance of the piece it has been subjected to the proper tests, including the rapid firing to which such a gun would be likely to be subjected in actual battle.

The board is of opinion that pieces of this type may safely be put to use in the Government service.

All firing records, target records, and star-gauge records are forwarded with this report.

A. MORDECAI,
Colonel, Ord. Dept., U. S. Army, President of Board.
F. H. PARKER,
Lieutenant-Colonel, Ord., Dept., U. S. Army.
FRANK HEATH,
Captain of Ordnance.
ORMOND M. LISSAK,
Lieutenant of Ordnance.

Star-gauging of 3.6-inch B. L. rifle (steel), No. 1, Watervliet Arsenal, West Troy, N. Y., dated May 29, 1890.

From breech of finished gun.	Diameter of finished bore within the lands.	Mean depth of grooves of rifling.	From breech of finished gun.	Diameter of finished bore within the lands.	Mean depth of grooves of rifling.	From breech of finished gun.	Diameter of finished bore within the lands.	Mean depth of grooves of rifling.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
23	3.600		46	3.600		69	3.601	
24	3.600		47	3.600		70	3.601	0.05
25	3.600	0.05	48	3.600		71	3.601	
26	3.600		49	3.600		72	3.601	
27	3.600		50	3.600	0.05	73	3.602	
28	3.600		51	3.600		74	3.602	
29	3.600		52	3.600		75	3.602	0.05
30	3.600	0.05	53	3.600		76	3.602	
31	3.600		54	3.600		77	3.602	
32	3.600		55	3.600	0.05	78	3.602	
33	3.600		56	3.600		79	3.602	
34	3.600		57	3.600		80	3.602	0.05
35	3.600	0.05	58	3.600		81	3.6025	
36	3.600		59	3.600		82	3.602	
37	3.600		60	3.600	0.05	83	3.6025	
38	3.600		61	3.600		84	3.6025	
39	3.600		62	3.600		85	3.602	0.05
40	3.600	0.05	63	3.600		86	3.602	
41	3.600		64	3.600		87	3.602	
42	3.600		65	3.601	0.05	88	3.602	
43	3.600		66	3.601		89	3.602	
44	3.600		67	3.601		90.7	3.602	0.05
45	3.600	0.05	68	3.601				

From breech of finished gun.	Diameter of powder and shot chamber.	From breech of finished gun.	Diameter of powder and shot chamber.
Inches.	*Inches.*	*Inches.*	*Inches.*
0		12	3.900
1		13	3.900
2		14	3.900
3		15	3.900
4		16	3.900 Powder
5		17	3.900 chamber.
6		18	3.900
7		19	3.900
8		20	3,900
9	3.900 Powder	21	3.900
10	3.900 chamber.	22	3.759 Shot chamber.
11	3.900		

Star-gauging of 3.6-inch B. L. rifle (steel), No. 1, Watervliet Arsenal, at Sandy Hook, N. J., August 8, 1890.

[3.6-inch ring.]

From muzzle.	After 62 rounds (lands).	Enlargement.	From muzzle.	After 62 rounds (lands).	Enlargement.	From muzzle.	After 62 rounds (lands).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
10	3.602	.000	36	3.600	.000	55	3.601	.001
12	3.601	—.001	38	3.601	+.001	56	3.601	.001
14	3.601	—.001	40	3.601	.001	57	3.601	.001
16	3.601	—.001	42	3.600	.000	58	3.6015	.0015
18	3.601	.000	44	3.600	.000	59	3.602	.002
20	3.601	.000	46	3.601	.001	60	3.6025	.0025
22	3.600	—.001	48	3.601	.001	61	3.602	.002
24	3.600	—.001	49	3.600	.000	62	3.603	.003
26	3.600	.000	50	3.601	.001	63	3.603	.003
28	3.600	.000	51	3.600	.000	64	3.6035	.0035
30	3.600	.000	52	3.601	.001	65	3.604	.004
32	3.600	.000	53	3.601	.001	66	3.604	.004
34	3.600	.000	54	3.601	.001	67	3.6045	.0045

Star-gauging of 3.6-inch B. L. rifle (steel), No. 1, Watervliet Arsenal, at Sandy Hook, N. J., August 8, 1890—Continued.

[3.9-inch ring.]

From breech.	After 62 rounds (powder chamber).	Enlargement.	From breech.	After 62 rounds (powder chamber).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
12	3.899	—.001	17	3.898	—.002
13	3.898	—.002	18	3.898	—.002
14	3.898	—.002	19	3.898	—.002
15	3.898	—.002	20	3.899	—.001
16	3.898	—.002	20¼	3.899	—.001

Star-gauging of 3.6-inch B. L. rifle (steel) No. 1, Watervliet Arsenal, at Sandy Hook, N. J., November 19, 1890.

[3.6-inch ring.]

From muzzle.	After 155 rounds (lands).	Enlargement.	From muzzle.	After 155 rounds (lands).	Enlargement.	From muzzle.	After 155 rounds (lands).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
0	3.601	—.001	28	3.601	.001	55	3.6025	.0025
2	3.6015	—.0005	30	3.601	.001	56	3.6025	.0025
4	3.6015	—.0010	32	3.601	.001	57	3.601	.001
6	3.602	.000	34	3.6015	.0015	58	3.6015	.0015
8	3.603	+.001	36	3.602	.002	59	3.602	.002
10	3.602	.000	38	3.602	.002	60	3.6025	.0025
12	3.602	.000	40	3.602	.002	61	3.602	.002
14	3.602	.000	42	3.6015	.0015	62	3.603	.003
16	3.602	.000	44	3.602	.002	63	3.603	.003
18	3.602	.001	46	3.602	.002	64	3.6035	.0035
20	3.602	.001	48	3.6015	.0015	65	3.604	.004
22	3.6015	.0005	50	3.6015	.0015	66	3.604	.004
24	3.6015	.0005	52	3.602	.002	67	3.6045	.0045
26	3.6015	.0015	54	3.602	.002			

[3.9-inch ring.]

From breech.	After 155 rounds (powder chamber, vertical).	Enlargement.	From breech.	After 155 rounds (powder chamber, vertical).	Enlargement.	From breech.	After 155 rounds (powder chamber, vertical).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
8¾	3.902	.002	12¾	3.901	.001	16¾	3.9005	.0005
9¾	3.902	.002	13¾	3.9005	.0005	17¾	3.9005	.0005
10¾	3.902	.002	14¾	3.9005	.0005	18¾	3.0005	.0005
11¾	3.902	.002	15¾	3.9005	.0005	19¾	3.9005	.0005

[3.9-inch ring.]

From breech.	After 155 rounds (powder chamber, horizontal).	Enlargement.	From breech.	After 155 rounds (powder chamber, horizontal).	Enlargement.	From breech.	After 155 rounds (powder chamber, horizontal).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
8¾	3.902	.002	12¾	3.901	.001	16¾	3.9005	.0005
9¾	3.9015	.0015	13¾	3.9005	.0005	17¾	3.9005	.0005
10¾	3.9015	.0015	14¾	3.9005	.0005	18¾	3.9005	.0005
11¾	3.901	.001	15¾	3.9005	.0005	19¾	3.902	.0002

Star-gauging of 3.6-inch B. L. rifle (steel), No. 1, Watervliet Arsenal, at Sandy Hook, N. J., March 20, 1891.

[3.6-inch ring.]

From muzzle.	After 251 rounds (lands).	Enlargement.	From muzzle.	After 251 rounds (lands).	Enlargement.	From muzzle.	After 251 rounds (lands).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
2	3.6015	—.0007	30	3.600	.0000	55	3.6015	.0015
4	3.601	—.001	32	3.6005	+.0005	56	3.602	.002
6	3.6015	—.0010	34	3.601	.001	57	3.6025	.0025
8	3.601	—.001	36	3.601	.001	58	3.603	.003
10	3.602	.0000	38	3.601	.001	59	3.603	.003
12	3.601	—.001	40	3.601	.001	60	3.603	.003
14	3.601	—.001	42	3.601	.001	61	3.604	.004
16	3.6015	—.0005	44	3.601	.001	62	3.604	.004
18	3.601	.0000	46	3.601	.001	63	3.605	.005
20	3.601	.0000	48	3.601	.001	64	3.6055	.0055
22	3.601	.0000	50	3.601	.001	65	3.606	.006
24	3.5985	—.0025	52	3.601	.001	66	3.6065	.0065
26	3.601	+.001	54	3.601	.001	66¾	3.6085	.0085
28	3.5985	—.0015						

[3.9-inch ring.]

From breech.	After 251 rounds (powder chamber, vertical).	Enlargement.	From breech.	After 251 rounds (powder chamber, vertical).	Enlargement.	From breech.	After 251 rounds (powder chamber, vertical).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
9¾	3.9035	.0035	13¾	3.902	.002	17¾	3.902	.002
10¾	3.903	.003	14¾	3.902	.002	18¾	3.902	.002
11¾	3.902	.002	15¾	3.902	.002	19¾	3.915	.015
12¾	3.902	.002	16¾	3.902	.002	20¾	3.901	.001

[3.9-inch ring.]

From breech.	After 251 rounds (powder chamber, horizontal).	Enlargement.	From breech.	After 251 rounds (powder chamber, horizontal).	Enlargement.	From breech.	After 251 rounds (powder chamber, horizontal).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
9¾	3.903	.003	13¾	3.9015	.0015	17¾	3.902	.002
10¾	3.903	.003	14¾	3.902	.002	18¾	3.9015	.0015
11¾	3.902	.002	15¾	3.902	.002	19¾	3.9015	.0015
12¾	3.902	.002	16¾	3.902	.002	20¾	3.902	.002

Star-gauging of 3.6-inch B. L. rifle (steel), No. 1, Watervliet Arsenal, at U. S. proving ground, Sandy Hook, N. J., April 22, 1891.

[3.6-inch ring.]

From muzzle.	After 457 rounds (lands).	Enlargement.	From muzzle.	After 457 rounds (lands).	Enlargement.	From muzzle.	After 457 rounds. (lands).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
2	3.6002	—.0018	32	3.603	.003	54½	3.610	.010
4	3.6015	—.0005	34	3.603	.003	55	3.613	.013
6	3.603	+.005	36	3.604	.004	56	3.607	.007
8	3.6035	.0015	38	3.603	.003	57	3.606	.006
10	3.6035	.0015	40	3.603	.003	58	3.606	.006
12	3.6035	.0015	42	3.603	.003	59	3.607	.007
14	3.604	.002	44	3.603	.003	60	3.607	.007
16	3.604	.002	46	3.604	.004	61	3.608	.008
18	3.603	.002	48	3.6045	.0045	62	3.608	.008
20	3.603	.002	50	3.604	.004	63	3.609	.009
22	3.6025	.0015	52	3.6035	.0035	64	3.610	.010
24	3.6025	.0015	53	3.605	.005	65	3.611	.011
26	3.6025	.0025	53½	3.605	.005	66	3.612	.012
28	3.602	.002	54	3.611	.011	66¾	3.614	.014
30	3.602	.002						

Star-gauging of 3.6-inch B. L. rifle (steel), No. 1, Watervliet Arsenal, at Sandy Hook, N. J., May 20, 1891.

[3.6-inch ring.]

From muzzle.	After 856 rounds (lands).	Enlargement.	From muzzle.	After 856 rounds (lands).	Enlargement.	From muzzle.	After 856 rounds (lands).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
10	3.6045	.0025	42	3.6035	.0035	61	3.611	.011
14	3.604	.002	46	3.6045	.0045	62	3.612	.012
18	3.6035	.0025	50	3.605	.005	63	3.6125	.0125
22	3.6025	.0015	54	3.611	.011	64	3.6145	.0145
26	3.6025	.0025	56	3.609	.009	65	3.6175	.0175
30	3.602	.002	58	3.610	.010	66	3.619	.019
34	3.6035	.0035	60	3.611	.011	66¾	3.621	.021
38	3.603	.003						

[3.9-inch ring.]

From breech.	After 856 rounds (powder chamber).	Enlargement.	From breech.	After 856 rounds (powder chamber).	Enlargement.	From breech.	After 856 rounds (powder chamber).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
10¾	3.904	.004	14¾	3.903	.003	18¾	3.903	.003
11¾	3.904	.004	15¾	3.903	.003	19¾	3.904	.004
12¾	3.904	.004	16¾	3.9025	.0025	20¾	3.904	.004
13¾	3.9025	.0025	17¾	3.903	.003			

Star-gauging of 3.6-inch B. L. rifle (steel), No. 1, Watervliet Arsenal, at Sandy Hook, N. J., July 29, 1891.

[3.6-inch ring.]

From muzzle.	After 1265 rounds (lands).	Enlargement.	From muzzle.	After 1265 rounds (lands).	Enlargement.	From muzzle.	After 1265 rounds (lands).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
10	3.6045	.0025	42	3.6035	.0035	61	3.6125	.0125
14	3.604	.002	46	3.606	.006	62	3.612	.012
18	3.603	.002	50	3.605	.005	63	3.614	.014
22	3.6025	.0015	54	3.613	.013	64	3.616	.016
26	3.602	.002	56	3.610	.010	65	3.619	.019
30	3.6025	.0025	58	3.610	.010	66	3.6215	.0215
34	3.6025	.0025	60	3.612	.012	66¾	3.625	.025
38	3.604	.004						

[3.9-inch ring.]

From breech.	After 1265 rounds (powder chamber).	Enlargement.	From breech.	After 1265 rounds (powder chamber).	Enlargement.	From breech.	After 1265 rounds (powder chamber).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
10¾	3.903	.003	14¾	3.9015	.0015	18¾	3.902	.002
11¾	3.902	.002	15¾	3.902	.002	19¾	3.902	.002
12¾	3.902	.002	16¾	3.9015	.0015	20¾	3.903	.003
13¾	3.9015	.0015	17¾	3.9015	.0015			

Star-gauging of 3.6-inch B. L. rifle (steel), No. 1, Watervliet Arsenal, at U. S. proving ground, Sandy Hook, N. J., September 28, 1891.

[3.6-inch ring.]

From muzzle.	After 1713 rounds (lands).	Enlargement.	From muzzle.	After 1713 rounds (lands).	Enlargement.	From muzzle.	After 1713 rounds (lands).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
0	3.6135	.0115	30	3.604	.0040	55	3.6155	.0155
2	3.607	.0050	32	3.604	.0040	56	3.613	.0130
4	3.6075	.0055	34	3.6045	.0045	57	3.613	.0130
6	3.608	.0055	36	3.604	.0040	58	3.614	.0140
8	3.610	.0080	38	3.6045	.0045	59	3.6145	.0145
10	3.610	.0080	40	3.605	.0050	60	3.615	.0150
12	3.610	.0080	42	3.606	.0060	61	3.6155	.0155
14	3.6065	.0045	44	3.607	.0070	62	3.6165	.0165
16	3.609	.0070	46	3.607	.0070	63	3.6165	.0165
18	3.607	.0060	48	3.6065	.0065	64	3.62	.0200
20	3.6055	.0045	50	3.6075	.0075	65	3.621	.0210
22	3.605	.0040	51	3.608	.0080	66	3.625	.0250
24	3.604	.0030	52	3.609	.0090	67	3.632	.0320
26	3.604	.0040	53	3.61	.0100			
28	3.604	.0040	54	3.612	.0120			

[3.9-inch ring.]

From breech.	After 1713 rounds (chamber, vertical).	Enlargement.	From breech.	After 1713 rounds (chamber, vertical).	Enlargement.	From breech.	After 1713 rounds (chamber, vertical).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
10¼	3.902	.002	14¼	3.900	.000	18¼	3.901	.001
11¼	3.902	.002	15¼	3.899	—.001	19¼	3.903	.003
12¼	3.902	.002	16¼	.....	.....	20¼	3.9025	.0025
13¼	3.9015	.0015	17¼	3.900	.000	21¼	3.905	.005

[3.9-inch ring.]

From breech.	After 1713 rounds (chamber, horizontal).	Enlargement.	From breech.	After 1713 rounds (chamber, horizontal).	Enlargement.	From breech.	After 1713 rounds (chamber, horizontal).	Enlargement.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
10¼	3.902	.002	14¼	3.901	.001	18¼	3.901	.001
11¼	3.902	.002	15¼	3.902	.002	19¼	3.9015	.0015
12¼	3.902	.002	16¼	3.902	.002	20¼	3.902	.002
13¼	3.9015	.0015	17¼	3.902	.002	21¼	3.903	.003

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to determine

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*	*Inches.*	*Feet.*	*Pounds.*
P M.....	1	Du Pont's I. K. G.; density, 1.725; granulation, 2,500.	4 0	Shell (banded), experimental, lot 249.	20 0 14 including sand.	69.58	1,393 1,394	No. 1, 29,040
	2	Du Pont's I. K. F.; density, 1.725; granulation, 2,016.	4 0		20 0 14 including sand.	69.58	1,380 1,387	No. 1, 28,480
	3		4 8		20 0 14 including sand.	69.58	1,478 1,484	No. 1, 31,290
	4		4 12		20 0 14 including sand.	69.58	1,524 1,529	No. 1, 24,400
	5		4 12		20 0 14 including sand.	69.58	1,527 1,532	No. 1, 35,100
	6		4 12		20 0 14 including sand.	69.58	1,519 1,525	No. 1, 34,480
	7	Du Pont's I. K. G.; density, 1.725; granulation, 2,500.	4 12		20 0 14 including sand.	69.58	1,584 1,587	No. 1, 41,180
	8		4 8		20 0 15 including sand.	69.58	1,535 1,539	No. 1, 37,140
	9		4 4		20 0 15 including sand.	69.58	1,482 1,485	No. 1, 32,380
	10		4 6		20 0 15 including sand.	69.58	1,507 1,512	No. 1, 33,900
	11	Du Pont's square L. X. W.; density, 1.720; granulation, 306.	4 8		20 0 15 including sand.	69.58	1,540 1,547	No. 1 '36,800
	12		4 8		20 0 15 including sand.	69.58	1,553 1,563	No. 1, 38,020
	13		4 6		20 0 12 including sand.	69.58	1,538 1,548	No. 1, 36,800
	14		4 4		20 0 12 including sand.	69.58	1,507 1,517	No. 1, 35,680
							$50+\frac{15}{2}^{2}$	

Cannon made at Watervliet Arsenal; weight of piece, 1,181 pounds; total length, 90.7 inches; length of bore, 83.7 inches; kind of carriage, Buffington steel field; kind of pressure gauge, crusher; location of pressure gauge, in face of obturator head; kind of ballistic instrument, Le Boulengé chronographs; kind of breech closure, De Bange slotted screw; diameter of powder chamber, 3.9 inches; nominal length of powder chamber, 14 inches; pitch of rifling, uniform, one turn in 35 calibers; number of grooves, 24; width of grooves, .3 inches; depth of grooves, .05 inches; width of lands, .17124 inches.

Watervliet Arsenal, at Sandy Hook, N. J., April 16, 1890.

suitability of powder for gun.]

Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Ft. In.		
14 6	Electric primer, model 1882, used.....	
13 6	.....	
15 0	Breechblock closed and opened with slight difficulty in rotating.	
18 6	Breechblock closed and opened with slight difficulty.	
18 6	Breechblock rotating in closing with slight difficulty.	
19 6	Breechblock closed and opened with slight difficulty.	
19 6	Front cup and carrier ring wiped off.....	
17 6	After this round it was observed that the left cap square was bent and right cap square slightly bent. The joint between sleeve and jacket had slightly opened on top and less on bottom.	
16 0	After this round it was observed that the wooden bed in tool-box of carriage was broken in two places.	
16 6	Breechblock opened with difficulty, requiring two hands.	
20 0	Trail swung to the left Breechblock opened with difficulty. Bending of both cap squares increased. Both cap square keys bent.	
16 6	Breechblock opened with difficulty, as before. Bending of both cap squares increased.	
16 0	Bending of both cap squares continues to increase.	
15 6	Breechblock closed with difficulty, requiring two hands to rotate, due to fouling on front cap and in gas-check seat.	

Gun mounted on Buffington steel field carriage No. 4. Spiral-spring brakes; clevis attachment.
Elevation, zero.
De Bange gas check.
Rounds 1 to 4, inclusive, copper cylinders of 28,000 pounds initial compression and tables of 1887 used.
Friction primers, long, used in rounds 2 to 11, inclusive.
Fired into field butt, section 1.
Rounds 5 to 12, inclusive, copper cylinders of 32,000 pounds initial compression and tables of 1887 used.
The cam was used in opening breechblock in starting translation.
Electric primers, model 1883.
Copper cylinders of 32,000 pounds initial compression and tables of 1887.
Firing conducted by the proof officer.

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, exhibition of

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
P. M. May 21	15	Du Pont's square L.X.W.; density, 1.720; granulation, 306.	*Lbs.* 4 *Oz.* 5	Shell (banded), experimental lot 249.	*Lbs.* 19 *Oz.* 8 6 including sand.	*Feet.* 1,551 50+½	*Pounds,* No. 1, 36,400

[Object of firing,

A. M. July 9	16	Du Pont's I. K. F.; density, 1.725; granulation, 2,016.	4 8	Shell (banded), experimental, lot 249.	19 0 1 0 sand. 20 0	----------	----------
July 9	17	Laflin & Rand's I. K., sample 1; density, 1.725; granulation, 2,116.	4 12		19 0 1 0 sand. 20 0	1,583 1,573	No. 1, 48,400
P. M. July 9	18		4 0		19 4 12 sand. 20 0	1,421 1,419	No. 1, 32,100
July 9	19	Laflin & Rand's I. K., sample 2; density, 1.725; granulation, 2,116.	4 8		19 3 13 sand. 20 0	1,514 1,518	No. 1, 37,400
July 9	20		4 8		19 4 12 sand. 20 0	1,524 1,519 50+½	No. 1, 37,060
A. M. July 10	21	Du Pont's I. K. F., density, 1.725; granulation, 2,016.	4 8		19 3 13 sand. 20 0	----------	----------
July 10	22	Du Pont's I. K.; density, 1.725; granulation, 2.666. Received July 9, 1891.	4 12		19 0 1 0 sand. 20 0	1,582 1,582	No. 1, 39,900
July 10	23		4 8		19 8 8 sand. 20 0	1,546 1,551 50+½	No. 1, 35,310
July 15	24	Du Pont's I. K. F.; density, 1,725; granulation, 2,016.	4 8		19 0 1 0 sand. 20 0	----------	----------
July 15	25	Du Pont's sphero-hexagonal W.O.; density, 1.730; granulation, 123.	4 8		19 3 13 sand. 20 0	Lost. 1,602	No. 1, 41,500
July 15	26	Du Pont's sphero-hexagonal W.N.; density, 1.720; granulation, 123.	4 8		19 3 13 sand. 20 0	1,560 1,563	No. 1, 35,260
July 15	27		4 8		19 0 1 0 sand. 20 1	1,571 1,574 50+½	No. 1, 35,200

Arsenal, at Sandy Hook, N. J., from May 21 to July 15, 1890.

gun before the Secretary of War.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet. 18	.....	.....	Gun mounted on Buffington steel field carriage No. 4. Spiral-spring brakes; clevis attachment. De Bange gas check. Fired into field butt. Copper cylinders of 32,000 pounds initial compression and tables of 1887. One chronograph, No. 101, used. Friction primers, long. Elevation, zero. Firing conducted by the proof officer.

to prove powder.]

14	Wind from left and rear, 13 miles an hour.	Warming charge	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. Copper cylinders of 28,000 pounds initial compression and tables of 1887. Friction primers, long, model 1887. Elevation, zero. Fired to sea. Before round 16, on account of bending of cap squares and deformation of chin-bolts, the carriage was returned to the national armory, and new and heavier cap squares, bolts, and keys were supplied. Samples of powder brought to the proving ground by the superintendent of the Laflin & Rand Powder Company, who was present during the firing. Copper cylinders of 32,000 pounds initial compression and tables of 1887 used in rounds 18, 19, and 20. Velocities and pressures taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
17		.....	
13		.....	
20		.....	
16		.....	
13	From left and rear, 14 miles an hour.	Warming charge	Gun mounted on Buffington steel field carriage No. 4. Spiral-spring brakes; clevis attachment. De Bange gas check. Friction primers, long, model 1887. Fired to sea. Copper cylinders of 32,000 pounds initial compression and tables of 1887. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
17		.....	
18		.....	
14	From left and rear, 11 miles an hour.	Warming charge; hook of handspike cracked nearly through after this round.	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. De Bange gas check. Fired into field butt, section 1. Friction primers, long, model 1887. Copper cylinders of 32,000 pounds initial compression and tables of 1887. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department, in rounds 26 and 27, and by Lieut Lissak, Ordnance Department, in round 25. Firing conducted by the proof officer.
17		.....	
19		.....	
18		.....	
14	From front and right, 11 miles an hour.	Warming charge; hook of handspike cracked nearly through after this round.	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. De Bange gas check. Fired into field butt, section 1. Friction primers, long, model 1887. Copper cylinders of 32,000 pounds initial compression and tables of 1887. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department, in rounds 26 and 27, and by Lieut Lissak, Ordnance Department, in round 25. Firing conducted by the proof officer.
17		.....	
19		.....	
18		.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
P. M. July 16	28	Du Pont's I. K. F.; density, 1.725; granulation, 2,016.	*Lbs. Oz.* 4 8	Shell (banded), experimental, lot 249.	*Lbs. Oz.* 19 2 natural weight.	*Feet.*	*Pounds.* .....
July 16	29	Laflin & Rand's I. K.; density, 173.081; granulation, 1,939. Sample received July 16, 1891.	4 8		19 4 12 sand. 20 0	1,520 1,518	No. 1, 46,000
July 16	30		4 8		19 2 14 sand. 20 0	1,521 1,522 50+½	No. 1, 46,000
July 24	31	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 8		19 3 13 sand. 20 0	.....	.....
July 24	32		4 8		19 2 14 sand. 20 0	1,609 1,619	No. 1, 50,980
July 24	33		4 8		19 12 4 sand. 20 0	1,508 1,520	No. 1, 34,200
July 24	34		4 8		19 2 14 sand. 20 0	1,509 1,509 50+½	No. 1, 35,080
July 24	35	Laflin & Rand's I. K. Sample received July 24, 1890.	4 8	Shell (banded), experimental, lot 249.	19 4 12 sand. 20 0	1,488 1,492	No. 1, 35,640
July 24	36		4 8		19 5 11 sand. 20 0	1,480 1,492	No. 1, 37,100
July 24	37		4 8		19 1 15 sand. 20 0	1,482 1,489	No. 1, 36,460

[Object of firing, to

P. M. July 24	38	Du Pont's I. K. H.; density, 1,725; granulation, 2,050.	5 0	Shell (banded), experimental, lot 249.	19 4 12 sand. 20 0	1,606 1,616 50+½	No. 1, 53,500

Watervliet Arsenal, at Sandy Hook, N. J., July 16 and 24, 1890.

to prove powder.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Fect.	From front and left, 9 miles an hour.	Warming charge. Hook of handspike cracked nearly through after this round.	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. De Bange gas check. Elevation, zero. Fired into field butt, section 1. Friction primers, long, model 1887. Copper cylinders of 32,000 pounds initial compression and tables of 1887. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by the proof officer.
.....			
17½		.....	
18		.....	
15	From front, 6 miles an hour.	.....	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. De Bange gas check. Elevation, zero. Cannon friction primers (experimental), with modified priming. Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1887. Pressures and velocities taken by Lieut. O. M. Lissak, Ordnance Department. Firing conducted by the proof officer.
18		.....	
17		.....	
16		.....	
15	Wind front, 6 miles an hour.	Warming charge; fired to sea	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. Elevation, zero. De Bange gas check. Cannon friction primers (experimental), with modified priming. Fired into field butt, section 1.
15		.....	
14		.....	

verify round No. 32.]

21	Wind front, 6 miles an hour.	.....	Copper cylinders of 32,006 pounds initial compression and tables of 1887. Elevation, zero. Pressures and velocity taken by Lieut. O. M. Lissak, Ordnance Department. Firing conducted by the proof officer.

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to determine

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*
July 28	39	Du Pont's I. K. F.; density, 1.725; granulation, 2,016.	4 0	Shells (banded), experimental, lot 249.	19 5 11 sand. 20 0	----------	----------
July 28	40	Du Pont's I.-K. H., lot 3; density, 1.725; granulation, 2,773. Second sample received July 24, 1890.	4 4		19 1 15 sand. 20 0	1,475 1,478	No. 1, 33, 385
July 28	41		4 8		19 4 12 sand. 20 0	1,518 1,521 50+$\frac{150}{2}$	No. 1, 37, 540

[Object of firing,

A. M.							
July 30	42	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 0		19 5 11 sand. 20 0	1,426 1,431	No. 1, 32, 140
July 30	43	Laflin & Rand's I. K.; lot 4. Sample received July 29, 1890.	4 0		19 3 13 sand. 20 0	1,405 1,400	No. 1, 32, 240
July 30	44		4 8		19 15 1 sand. 20 0	1,506 1,512	No. 1, 39, 640
July 30	45		4 8		19 0 1 0 sand. 20 0	1,510 1,514	No. 1, lost.
July 30	46		4 8		19 1 15 sand. 20 0	Lost	No. 1, 41, 800
Aug. 1	47	Du Pont's I. K H., lot 1; density, 1.725; granulation, 2,050.	4 0		19 1 15 sand. 20 0	1,425 1,429	----------
Aug. 1	48	Laflin & Rand's I. K., lot 5, received August	4 0		19 1 15 sand. 20 0	1,397 1,398	No. 1, 32, 160
Aug. 1	49		4 4		19 1 15 sand. 20 0	1,452 1,453	No. 1, 36, 860
Aug. 1	50	Sample received August 1, 1890.	4 4		19 1 15 sand. 20 0	1,451 1,453	No. 1, 34, 220
P. M.							
Aug. 1	51	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 0		19 2 14 sand. 20 0	----------	----------
						50+$\frac{150}{2}$	

Arsenal, at Sandy Hook, N. J., from July 28 to August 1, 1890.

suitability of powderf or gun.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet. 11	From front and right, 12 miles an hour.	Warming charge	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. Elevation, zero. De Bange gas check. Cannon friction primers (modified priming), lot of March, 1890. Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1887. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
16		.....	
15		.....	

to prove powder.]

Feet. 11	From front, 7 miles an hour.	.....	
12		.....	
13		.....	
14		Pressure indicated by cylinders; unreliable copper split.	
13		Wires of second velocity target not cut; projectile missed target.	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. De Bange gas check. Elevation, zero. Cannon friction primers (experimental), with modified priming, March, 1890. Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1887.
12	From rear, 5 miles an hour.	Warming charge	
12		.....	
13½		.....	
13		.....	
11		Warming charge fired to sea.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*
Aug. 1	52	Laflin & Rand's I. K., lot 5. Sample received August 1, 1890.	4 4	Shell (banded), experimental, lot 249.	19 3 13 sand. 20 0	1,452 1,456	No. 1, 36, 890
Aug. 1	53		4 4		19 3 13 sand. 20 0	1,449 1,453	No. 1, 34, 500
Aug. 5	54	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 0		19 2 14 sand. 20 0	.....	.....
Aug. 5	55	Laflin & Rand's I. K., lot 5; density, —; granulation, 2,258. Sample received August 5, 1890.	4 4		19 4 12 sand. 20 0	1,413 1,417	No. 1, 32, 000
Aug. 5	56		4 4		19 0 1 0 sand. 20 0	1,421 1,424	No. 1, 32, 220
Aug. 5	57		4 8		19 3 13 sand. 20 0	1,454 1,458	No. 1, 33, 800
A. M.							
Aug. 6	58	Du Pont's I.K.H., lot1; density, 1.725; granulation, 2,050.	4 0		19 0 1 0 sand. 20 0	1,418 1,419	.....
Aug. 6	59	Laflin & Rand's I. K., lot 5; density, —; granulation, 2,258. Sample received August 5, 1890.	4 12		19 2 14 sand. 20 0	1,524 1,531	No. 1, 44,000
Aug. 6	60		4 8		19 0 1 0 sand. 20 0	1,471 1,472	No. 1, 36, 845
Aug. 6	61		4 8		19 1 15 sand. 20 0	1,478 1,480	No. 1, 37, 630

[Object of firing, to determine

A. M. Aug. 6	62	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 10	Shell (banded), experimental, lot 249.	19 0 1 0 sand. 20 0	1,531 1,535 $50+\frac{15}{2}^{0}$	No. 1, 38, 780
P. M. Aug. 11	63		4 0		19 3 13 sand. 20 0	1,411 1,412	.....

Watervliet Arsenal, at Sandy Hook, N. J., August 1 to 11, 1890.

to prove powder.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
14	From rear, 5 miles an hour.	.....	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. De Bange gas check. Cannon friction primers (experimental), with modified priming, March, 1890. Fired to sea. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by the proof officer.
13		.....	
17	From front and right, 22 miles an hour.	Warming charge	
15		.....	
14½		.....	
16		.....	
14	From right and front, 6 miles an hour.	Warming charge.....	
19½		.....	
14		.....	
17		.....	

suitability of powder for gun.]

16	From right and front, 6 miles an hour.	.....	Gun mounted on Buffington steel field carriage No. 4. Spiral-spring brakes; clevis attachment. Elevation, zero. De Bange gas check. Fired to sea. Cannon friction primers (experimental), with modified priming, March, 1890. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Dept., assistant proof officer.
14	Wind from rear, 28 Miles an hour.	Warming charge.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to determine

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*
Aug. 11	64	Du Pont's I. K. H., lot 6; density, 1.725; granulation, 2,809. Sample received August 9, 1890.	4 8	Shell (banded), experimental, lot 249.	19 4 12 sand. 20 0	1,525 1,527	No. 1, 35, 635
Aug. 11	65		4 8		19 4 12 sand. 20 0	1,525 1,527	No. 1, 36, 680
Aug. 12	66	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 0		19 2 14 sand. 20 0	1,401 1,405	.....
Aug. 12	67	Du Pont's I. K. H., lot 6; density, 1.725; granulation, 2,809. Sample received August 9, 1890.	4 8		19 4 12 sand. 20 0	1,529 1,532	No. 1, 35, 700
Aug. 12	68		4 10		19 1 15 sand. 20 0	1,551 1,557	No. 1, 39, 600
						$50+\frac{15}{2}^{0}$	

[Object of firing,

A. M.							
Aug. 20	69	Du Pont's I. K. H., lot 2; density, 1.725; granulation, 2,050.	4 0	Shell (banded), experimental, lot 249.	19 4 natural weight.	.....	.....
Aug. 20	70	Lafflin and Rand's I. K., lot 6; density, ——; granulation, 1,861. Sample received, August 19, 1890.	4 4		19 3 13 sand. 20 0	1,472 1,472	No. 1, 36, 660
Aug. 20	71		4 4		19 6 10 sand. 20 0	1,472 1,474	No. 1, 36, 440
Aug. 20	72	Lafflin and Rand's I. K., lot 7; density, ——; granulation, 2,076. Sample received August 19, 1890.	4 4		19 5 11 sand. 20 0	1,415 1,414	No. 1, 32, 200
Aug. 20	73		4 8		19 5 11 sand. 20 0	1,459 1,461	No. 1, 33, 820
Aug. 20	74		4 12		19 0 1 0 sand. 20 0	1,510 1,509	No. 1, 38, 725
Aug. 20	75		4 12		19 13 3 sand. 20 0	1,506 1,508	No. 1, 37, 070
Aug. 20	76	Lafflin and Rand's I. K., lot 8; density, ——; granulation, 1,966. Received August 19, 1890.	4 8		19 4 12 20 0	1,495 1,495	No. 1, 36, 510
						$50+\frac{15}{2}^{0}$	

Watervliet Arsenal, at Sandy Hook, N. J., August 11 to 20, 1890.

suitability of powder for gun.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet. 18	Wind from rear, 28 miles an hour.	.....	
.....		.....	Gun mounted on Buffington steel field carriage No. 4. Spiral-spring brakes; clevis attachment. Elevation, zero. De Bange gas check. Fired to sea. Cannon friction primers (experimental), with modified priming, March, 1890. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
12	Wind from right and front, 17 miles an hour.	Warming charge	
20		.....	
16		.....	

to prove powder.]

19	From rear and left, —— miles an hour.	Warming charge	
19		.....	
19		.....	
18		.....	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. Elevation, zero. De Bange gas check. Cannon friction primers (experimental), with modified priming, March, 1890. Fired to sea. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
18		.....	
18		.....	
18		.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test suita-

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*
Aug. 27	77	Du Pont's I. K. H., lot 7; density, ——; granulation, 2,630.	4 0	Shell (banded), experimental, lot 249.	18 13 1 3 sand. 20 0	1,453 1,455	No. 1, 32,660
Aug. 27	78	Du Pont's I. K. H., lot 7; keg 2; density, 1.725; granulation, 2,664. Received Aug. 22, 1890.	4 8		19 0 1 0 sand. 20 0	1,535 1,540	No. 1, 40,090
Aug. 27	79		4 4		19 3 13 sand. 20 0	1,483 1,484	No. 1, 36,500
Aug. 27	80	Du Pont's I. K. H., lot 8; keg 2; density, 1.725; granulation, 2,444. Received Aug. 22, 1890.	4 4		18 3 1 13 sand. 20 0	1,488 1,486	No. 1, 34,520
Aug. 27	81		4 6		19 2 14 sand. 20 0	1,509 1,511	No. 1, 41,880

[Object of firing,

P. M. Aug. 29	82	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 0	Shell (banded), experimental, lot 249.	19 1 15 sand. 20 0	1,429 1,431	No. 1, 31,100
Aug. 29	83	Du Pont's sphero-hexagonal U. N.; density, 1,720; granulation, 123.	4 4		19 2 14 sand. 20 0	1,515 1,517	No. 1, 33,330
Aug. 29	84		4 8		19 3 13 sand. 20 0	1,578 1,577	No. 1, 34,975
Aug. 29	85		4 8		19 4 12 sand. 20 0	1,572 1,572	No. 1, 35,000
Aug. 29	86		4 8		19 2 14 sand. 20 0	1,573 1,572	No. 1, 34,565
A. M. Sept. 4	87	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 0		19 3 13 sand. 20 0	1,421 1,423	.....

Arsenal, at Sandy Hook, N. J., from August 27 to September 4, 1890.

bility of powder for gun.]

Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.		
15	Warming charge	
18	.....	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. Elevation, zero. De Bange gas check. Fired into field butt, section 1. Cannon friction primers (experimental), with modified priming, March, 1890. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
14	.....	
14	.....	
20	.....	

to prove powder.]

13	Warming charge	
13½	.....	
21	.....	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. Elevation, zero. De Bange gas check. Cannon friction primers (experimental), with modified priming, March, 1890. Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
16	.....	
16	.....	
13	Warming charge	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*	*Feet.*	*Pounds.*
A. M. Sept. 4	88	Laflin and Rand's I. K., lot 9; density, —; granulation, 2,017. Sample received September 3, 1890.	4 4	Shell (banded), experimental, lot 249.	19 3 13 sand. 20 0	1,412 1,412	No. 1, 32, 030
Sept. 4	89		4 8		19 2 14 sand. 20 0	1,465 1,463	No. 1, 33, 180
Sept. 4	90		4 12		19 2 14 sand. 20 0	1,513 1,512	No. 1, 39, 580
Sept. 4	91		4 10		19 3 13 sand. 20 0	1,494 1,498	No. 1, 36, 900
Sept. 4	92		4 10		19 3 13 sand. 20 0	1,499 1,496	No. 1, 36, 550
Sept. 4	93	Laflin and Rand's I. K, lot 10; density, —; granulation, 2,216. Sample received September 3, 1890.	4 8		19 4 12 sand. 20 0	1,503 1,509	No. 1, 41, 400
Sept. 4	94		4 4		19 2 14 sand. 20 0	1,454 1,454	No. 1, 34, 310
Sept. 4	95		4 6		19 2 14 sand. 20 0	1,484 1,489	No. 1, 37, 200
Sept. 4	96		4 6		18 11 1 5 sand. 20 0	1,481 1,485 50+$\frac{15}{2}$°	No. 1, 37, 665
P. M. Sept. 8	97	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 0		19 4 12 sand. 20 0	1,428 1,429	----------
Sept. 8	98	Du Pont's sphero-hexagonal U. R.; density, 1.700; granulation, 122.	4 0		19 2 14 sand. 20 0	1,471 1,470	No. 1, 32, 880
Sept. 8	99		4 6		19 2 14 sand. 20 0	1,458 1,462	No. 1, 35, 780
Sept. 8	100	Sample received Sept. 4, 1890. Sample received Aug. 9, 1890.	4 6		19 2 14 sand. 20 0	1,559 1,563	No. 1, 36, 240
Sept. 8	101		4 6		19 2 14 sand. 20 0	1,557 1,557	No. 1, 36, 041

Watervliet Arsenal, at Sandy Hook, N. J., September 4 and 8, 1890.

to prove powder.]

Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.		
13½	.....	
16	.....	
16	.....	
26	.....	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment.
14½	.....	Elevation, zero. De Bange gas check. Cannon friction primers (experimental), with modified priming, March, 1890.
15	.....	Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W W. Gibson, Ordnance Department, assistant proof officer.
13½	.....	
15½	.....	
14	.....	
12	Warming charge	
16	.....	
16	.....	Gun mounted on Buffington steel field carriage, No. 4, with spiral-spring brakes; clevis attachment.
18	.....	De Bange gas check. Cannon friction primers (experimental), with modified priming, March, 1890.
16½	.....	Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firng conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
16	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*	*Feet.*	*Pounds.*
P. M. Sept. 8	102	Du Pont's sphero-hexagonal U. S.; density, 1.685; granulation, 122. Sample received Aug. 9, 1890.	4 6	Shell (banded), experimental, lot 249.	19 1 15 sand. 20 0	1,556 1,560	No. 1, 37,220
Sept. 8	103	Sample received Sept. 4, 1890.	4 6		19 2 14 sand. 20 0	1,562 1,567	No. 1, 36,460
Sept. 8	104		4 6		19 1 15 sand. 20 0	1,562 1,557	No. 1, 37,240
Sept. 8	105		4 6		19 4 12 sand. 20 0	1,561 1,560	No. 1, 38,470
						$50+\frac{150}{2}$	
Sept. 30	106	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 8		19 3 13 sand. 20 0	1,532 1,537	.....
A.M. Sept. 30	107	Du Pont's U. U., keg 1; density, 1.725; granulation, 2,976. Sample received Sept. 29, 1890.	4 0		19 4 12 sand. 20 0	1,442 1,455	No. 1, 32,240
Sept. 30	108		4 4		19 1 15 sand. 20 0	1,487 1,491	No. 1, 41,660
Sept. 30	109		4 0		19 4 12 sand. 20 0	1,443 1,449	No. 1, 39,000
Sept. 30	110		4 0		19 $3\frac{1}{2}$ $12\frac{1}{2}$ sand. 20 0	1,445 1,449	No. 1, 32,100
Sept. 30	111		4 0		19 1 15 sand. 20 0	1,425 1,430	No. 1, 32,050
Sept. 30	112		4 4		19 4 12 sand. 20 0	1,465 1,470	No. 1, 32,300
Sept. 30	113		4 4		19 3 13 sand. 20 0	1,473 1,478	No. 1, 32,300
						$50+\frac{150}{2}$	
Sept. 30	114	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 0		19 12 4 sand. 20 0	.....	.....

Arsenal, at Sandy Hook, N. J., September 8 and 30, 1890.

to prove powder.]

Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.		
16	.....	
16	Knob to handle of elevating gear broken off.	
18	.....	
.....	.....	
20	Warming charge	
14	.....	Gun mounted on Buffington steel field carriage, No. 4, spiral-spring brakes; clevis attachment. De Bange gas check. Cannon friction primers (experimental), with modified priming, March, 1890. Fired into field butt, section 2. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
17	Right brake jumped off wheel in recoiling.	
15	.....	
12	.....	
13½	.....	
14	.....	
16	.....	
12	Warming charge; fired to sea.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*
Sept. 30	115	Du Pont's U. U., keg 2; density, 1.725; granulation, 2,976. Sample received Sept. 29, 1890.	4 6	Shell (banded), experimental, lot 249.	19 1 15 sand. 20 0	1,503 1,506	No. 1, 33,460
Sept. 30	116		4 8		19 4 12 sand. 20 0	1,529 1,531	No. 1, 35,220
Sept. 30	117		4 8		19 12 4 sand. 20 0	1,529 1,531	No. 1, 35,460
Sept. 30	118	Du Pont's U. V., keg 1; density, ||; granulation, 2,751.	4 4		19 6 10 sand. 20 0	1,485 1,486	No. 1, 35,990
Sept. 30	119	Du Pont's U. V., keg 2; density, 1.725; granulation, 2,751. Sample received Sept. 29, 1890.	4 4		19 3 13 sand. 20 0	1,480 1,474	No. 1, 32,400
Sept. 30	120		4 4		19 4 12 sand. 20 0	1,479 1,480	No. 1, 32,620
Sept. 30	121		4 8		19 4 12 sand. 20 0	1,524 1,533	No. 1, 34,520
Sept. 30	122		4 8		19 5 11 sand. 20 0	1,528 1,523 50+$\frac{15}{2}$	No. 1, 38,160

Watervliet Arsenal, at Sandy Hook, N. J., September 30, 1890.

to prove powder.]

Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.		
14½	.....	
17	.....	
14	.....	
14	.....	Gun mounted on Buffington steel field carriage No. 4. Spiral-spring brakes; clevis attachment.
14	.....	Cannon friction primers (experimental), with modified priming, March, 1890.
14	.....	Fired into field butt, section 2. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
13½	.....	
16	Right-brake jumped off wheel in recoiling.	
20	Right-brake jumped off wheel in recoiling.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
			Lbs. Oz.		*Lbs. Oz.*	*Feet.*	*Pounds.*	*Feet.*
P. M. Oct. 1	123	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 0	Shell (banded), experimental, lot 249.	19 1 15 sand. = 20 0	.....	.....	16
Oct. 1	124	Laflin & Rand's I. K.; density, —; granulation, 1,872. Sample 11, received Oct. 1, 1890.	4 0		19 0 / 1 0 sand. = 20 0	1,348 / 1,349	No. 1, 28,130	18
Oct. 1	125		4 4		19 5 / 11 sand. = 20 0	1,395 / 1,395	No. 1, less than 32,000.	14½
Oct. 1	126		4 6		19 4 / 12 sand. = 20 0	1,423 / 1,426	No. 1, 32,940	14½
Oct. 1	127		4 9		19 6 / 10 sand. = 20 0	1,458 / 1,458	No. 1, 33,180	19
Oct. 1	128		4 12		19 2 / 14 sand. = 20 0	1,492 / 1,494	No. 1, 34,160	19
Oct. 1	129	Laflin & Rand's I. K.; density, —; granulation, 1,749. Sample received Oct. 1, 1890.	4 0		19 3 / 13 sand. = 20 0	Lost. / 1,340	No. 1, less than 28,000	12
Oct. 1	130		4 6		19 4 / 12 sand. = 20 0	1,416 / 1,416	No. 1, 28,100	14
Oct. 1	131		4 10		18 14 / 1 2 sand. = 20 0	1,463 / 1,461	No. 1, 32,100	16
Oct. 1	132		4 12		19 3 / 13 sand. = 20 0	1,489 / 1,490	No. 1, 32,500	18
Oct. 1	133	Laflin & Rand's I. K., sample 12; density,—; granulation, 1.749. Received Oct. 1, 1890.	4 12		19 4 / 12 sand. = 20 0	1,482 / 1,484	No. 1, 32,600	20
Oct. 1	134	Laflin & Rand, sample 11; density, 1.725; granulation, 1.872. Received Oct. 1, 1890.	4 14		18 14 / 1 2 sand. = 20 0	1,530 / 1,539	No. 1, 37,890	25
						50+½		

Watervliet Arsenal, at Sandy Hook, N. J., October 1, 1890.

to prove powder.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
From right and front, 10 miles an hour.	Warming charge; fired to sea.	Gun mounted on Buffington steel field carriage No. 4. Spiral-spring brakes; clevis attachment. Elevation, zero. De Bange gas check. Cannon friction primers (experimental), with modified priming, March, 1890. Fired into field butt, section 2. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 131 to 134, inclusive. Superintendent of Laflin & Rand Powder Company present.
	Copper cylinders of 28,000 pounds initial compression and tables of 1887.	
	Copper cylinders of 32,000 pounds initial compression and tables of 1890.	
	Copper cylinders of 28,000 pounds initial compression and tables of 1887.	
	Copper cylinders of 32,000 pounds initial compression and tables of 1890.	
	Copper cylinders of 32,000 pounds initial compression and tables of 1890.	
	Copper cylinders of 28,000 pounds initial compression and tables of 1887.	
	Copper cylinders of 28,000 pounds initial compression and tables of 1887.	
	.....	
	.....	
	.....	
	.....	
	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*	*Feet.*
Oct. 15	135	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 0	Shell (banded), experimental, lot 249.	19 6 10 sand. 20 0	1,417 1,421	----------	20
Oct. 15	136	Laflin & Rand's I. K., lot 1; density, ——; granulation, 2,043. Received Oct. 15, 1890.	4 4		19 1 15 sand. 20 0	1,458 1,461	No. 1, 33,060	20
Oct. 15	137		4 10		19 5 11 sand. 20 0	1,536 1,539	No. 1, 39,975	20
Oct. 15	138		4 8		19 5 11 sand. 20 0	1,509 1,515	No. 1, 38,040	20
Oct. 15	139		4 8		19 0 1 0 sand. 20 0	1,516 1,515	No. 1, 37,380	18
Oct. 15	140		4 8		19 2 14 sand. 20 0	1,508 1,509	No. 1, 38,680	17
Oct. 31	141	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 8		19 4 12 sand. 20 0	50+$\frac{150}{2}$ 1,519 1,522	----------	18
Oct. 31	142	Laflin & Rand's I. K., lot 13; granulation, 1,988. Received October 29, 1890.	4 4		19 1 15 sand. 20 0	1,451 1,456	No. 1, 30,460	24
Oct. 31	143		4 8		19 5 11 sand. 20 0	1,499 1,499	No. 1, 33,870	24
Oct. 31	144		4 10		19 5 11 sand. 20 0	1,520 1,522	No. 1, 35,200	20
Oct. 31	145		4 10		19 2 14 sand. 20 0	1,526 1,526	No. 1, 37,615	24
Oct. 31	146		4 10		19 5 11 sand. 20 0	1,526 1,526	No. 1, 35,060	24
Oct. 31	147		4 12		19 4 12 sand. 20 0	1,546 1,546	No. 1, 36,935	28
Oct. 31	148		4 12		19 2 14 sand. 20 0	1,548 1,550	No. 1, 36,875	24
Oct. 31	149	Laflin & Rand's I. K., lot 13; granulation, 1,988. Received October 29, 1890.	4 12	Shell (banded), experimental, lot 249.	19 3 13 sand. 20 0	1,549 1,548	No. 1, 37,815	28

Watervliet Arsenal, at Sandy Hook, N. J., October 15 and 31, 1890.

to prove powder.]

Wind, strength and direction.	Special remarks about each fire, such as effec t on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
From right and rear, 10 miles an hour.	Warming charge. Right brake jumped off wheel in recoiling.	
	Right brake jumped off wheel in recoiling. Copper cylinders of 28,000 pounds initial compression and tables of 1887.	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment.
	Right brake jumped off wheel in recoiling.	De Bange gas check.
		Cannon friction primers (experimental), with modified priming, March, 1890.
		Fired into field butt, section 2.
	Right brake jumped off wheel in recoiling.	Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 137 to 140, inclusive.
		Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department.
	Sample of powder brought to the proving grounds by the superintendent of the Laflin & Rand Powder Company, who was present during the firing.	Firings conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
	.....	
	Warming charge.....	
	Copper cylinders of 28,000 ponnds initial compression and tables of 1887.	
	Right brake jumped off wheel in recoiling.	
	.....	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brake; clevis attachment.
	Right brake jumped off wheel in recoiling.	Elevation, zero.
		De Bange gas check.
		Cannon friction primers (experimental), with modified priming, March, 1890.
		Fired into field butt, section 2.
	Right brake jumped off wheel in recoiling.	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
	Right brake jumped off wheel in recoiling.	Constant battery. De Wolski cells first used October 31, 1890.
		Battery set up October 21 to 23, 1890.
		Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department.
	Right brake jumped off wheel in recoiling.	
	.....	
	Right brake jumped off wheel in recoiling.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*	*Feet.*
Nov. 18	150	Du Pont's I. K. H.; density, 1.725; granulation, 2,050.	4 0	Shell (banded), experimental, lot 249.	18 14 1 2 sand. 20 0	.....	.....	13
Nov. 18	151	Laflin & Rand's I. K., lot 14; density, —; granulation, 2,073. Sample received November 17, 1890.	4 4		19 2 14 sand. 20 0	1,451 1,449	No. 1, 32,030	16
Nov. 18	152		4 9		19 1 15 sand. 20 0	1,513 1,509	No. 1, 35,580	19
Nov. 18	153		4 12		19 2 14 sand. 20 0	1,548 1,552	No. 1, 42,000	19
Nov. 18	154		4 9		19 0 1 0 sand. 20 0	1,514 1,511	No. 1, 37,510	19
Nov. 18	155		4 9		19 1 15 sand. 20 0	1,511 1,514	No. 1, 35,200	18
Dec. 4	156	Du Pont's I. K. H., lot 1; density, 1.725; granuation, 2,050.	4 8		19 1 15 sand. 20 0	1,508 1,502	.....	14
Dec. 4	157	Du Pont's U. W., received Dec. 2, 1890; density, 1.725; granulation, 1,898.	4 0		19 3 13 sand. 20 0	1,360 1,356	No. 1, less than 32,000.	13
Dec. 4	158		4 8		19 0 1 0 sand. 20 0	1,441 1,439	No. 1, 29,260	15
Dec. 4	159		4 12		19 2 14 sand. 20 0	1,484 1,480	No. 1, 32,180	17
Dec. 4	160		4 12		19 1 15 sand. 20 0	1,470 1,467	No. 1, 34,980	21
Dec. 4	161		4 12		19 2 14 sand. 20 0	1,477 1,477	No. 1, 30,905	17

50+1gs

Arsenal, at Sandy Hook, N. J., November 18 and December 4, 1890.

to prove powder.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
From front 12 miles an hour.	Warming charge. Left brake jumped off wheel in recoiling.	
	....	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment.
	.....	Elevation, zero.
		De Bange gas check.
		Fired into field butt, section 2.
		Cannon friction primers (experimental), with modified priming, March, 1890.
	.....	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
		Gun star-gauged after round 155, November 19, 1890, by Lieut. O. M. Lissak, Ordnance Department.
	.....	Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department.
		Firing conducted by Lieut. W. W. Gibson, Ordnance Department.
	.....	
From right and rear 12 miles an hour.	Warming charge	
	Copper cylinders of 32,000 pounds initial compression and tables of 1890.	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment.
	.....	Elevation, zero.
		De Bange gas check.
		Cannon friction primers (experimental), with modified priming, March, 1890.
		Fired into field butt, section 2.
	.....	Copper cylinders of 28,000 pounds initial compression and tables of 1887.
	Right brake jumped off wheel in recoiling.	Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department.
	Copper cylinders of 28,000 pounds initial compression and tables of 1887.	Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*	*Feet.*
Dec. 5	162	Du Pont's I. K. H., lot 1; density, 1.725; granulation, 2,050.	4 0	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	1,383 1,386	.....	19
Dec. 5	163	Du Pont's U. X.; density, 1.725; granulation, 2, 215. Received December 2, 1890.	4 8		19 1 15 sand. 20 0	1,448 1,445	No. 1, 30, 730	19
Dec. 5	164		4 12		19 3 13 sand. 20 0	1, 505 1, 505	No. 1, 45, 250	17
Dec. 5	165		4 8		19 2 14 sand. 20 0	1,461 1,459	No. 1, 37, 850	18
Dec. 5	166		4 8		19 2 14 sand. 20 0	1,454 1,451 50+$\frac{15}{2}$	No. 1, 32, 170	16

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, test of Frankford Arsenal combination

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile Kind.	Projectile Weight.	Elevation.	Fuse marked.	Fuse set at seconds.
			Lbs. Oz.		*Lbs. Oz.*	′		
	167	Du Pont's I. K. H., lot 16; density, 1.725; granulation, 2,524.	4 0	Shell, experimental, lot 249.	19 1 15 sand. 20 0	10	.....	.....
P. M	168		4 0	Shell (banded), experimental, lot 249, with Frankford Arsenal combination fuse (modified Danish), in housing.	20 7	10	A	5
	169		4 0		20 0	10	B	3

Watervliet Arsenal, at Sandy Hook, N. J., December 5, 1890.

to prove powder.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	Warming charge. Right brake pumped off wheel in recoiling.	Gun mounted on Buffington steel field carriage No. 4, with spiral-spring brakes; clevis attachment. Elevation, zero. De Bange gas check. Cannon friction primers (experimental), with modified priming, March, 1890. Fired into field butt, section 2. Copper cylinders of 28,000 pounds initial compression and tables of 1887 used in rounds 163 to 165, inclusive. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
.....	Right brake jumped off wheel in recoiling.	
.....	.....	
.....	.....	
.....	Copper cylinders of 32,000 pounds initial compression and tables of 1890.	

Watervliet Arsenal, at Sandy Hook, N. J., December 18, 1890.

fuse (modified Danish), fired in housing and recovered.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.	Wind from rear, 20 miles an hour.	Sighting shot	Gun mounted on Buffington steel field carriage No. 4. Spiral-spring brakes; clevis attachment. De Bange gas check. Fuse A, Frankford Arsenal percussion plunger. Fired into sand butt, section 1. Fuse B, modified Danish, percussion plunger. Cannon friction primers (experimental), with modified priming, March, 1890. Firing conducted by the proof officer.
11			
12		Rear plunger removed before firing. On firing front plunger had operated, exploding percussion composition; brass covering of plunger forced into vents surrounding steel point, closing them; lead cylinder of plunger drawn forward into point; time composition not ignited.	
12		Rear plunger removed before firing. On firing front plunger had operated, exploding percussion composition; brass covering of plunger forced into vents surrounding steel point, partially closing them; lead cylinders of plunger drawn forward into point; time train ignited and consumed.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*	*Feet.*
Dec. 27	170	Du Pont's I. K. H., lot 1; density, 1,725; granulation, 2,050.	4 0	Shell (banded), experimental, lot 249.	19 4 12 sand. 20 0	.....	.....	18
Dec. 27	171	Laflin & Rand's I. K., lot 15; density, ——; granulation, 2,380. Sample received Dec. 24, 1890.	4 0		19 3 13 sand. 20 0	1,385 1,382	No. 1, 27,000	9½
Dec. 27	172		4 4		19 3 13 sand. 20 0	1,435 1,430	No. 1, 28,870	12
Dec. 27	173		4 8		19 2 14 sand. 20 0	1,484 1,477	No, 1, 30,905	13
Dec. 27	174		4 8		19 5 11 sand. 20 0	1,482 1,478	No. 1, 30,200	13½
Dec. 27	175		4 12		19 2 14 sand. 20 0	1,538 1,532	No. 1, 38,880	15
Dec. 27	176		4 12		19 2 14 sand. 20 0	1,535 1,520	No. 1, 32,985	15
Dec. 27	177		4 12		19 1 15 sand. 20 0	1,525 1,521	No. 1, 33,265	15
Dec. 27	178		4 12		19 2 14 sand. 20 0	1,530 1,525	No. 1, 34,240	16
						50+1½		
A. M. Dec. 29	179	Du Pont's I. K. H., lot 16; density, 1.725; granulation, 2,524.	4 0		19 2 14 sand. 20 0	.....	.....	11
Dec. 29	180	Laflin & Rand's I. K., lot 16; density, ——; granulation, 2,156. Sample received Dec. 24, 1890.	4 4		19 5 11 sand. 20 0	1,456 1,451	No. 1, 31,200	10½
Dec. 29	181		4 8		19 2 14 sand. 20 0	1,513 1,516	No. 1, 42,600	10
Dec. 29	182		4 6		18 13 1 3 sand. 20 0	1,478 1,476	No. 1, 33,965	11
Dec. 29	183		4 8		19 5 11 sand. 20 0	1,506 1,501	No. 1, 38,200	13

Arsenal, at Sandy Hook, N. J., December 27 and 29, 1890.

to prove powder.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
From right and rear, 22 miles an hour.	Clevis attachment of right brake broken.	Gun mounted on Buffington steel field carriage No. 4, with old spiral-spring brakes. Elevation, zero. Spiral-spring brakes, clevis attachment, used in round 170. Cannon friction primers (experimental), with modified priming, March, 1890. Fired into field butt, section 1. Copper cylinders of 28,000 pounds initial compression and tables of 1887 used in rounds 172 to 174, inclusive. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 176 to 178, inclusive. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
	Copper cylinders of 24,000 pounds initial compression and tables of 1887 used.	
	.....	
	.....	
	Copper cylinders of 28,000 pounds initial compression and tables of 1887 used.	
	Left brake jumped off wheel in recoiling.	
	.....	
	.....	
From right and rear, 10 miles an hour.	Warming charge	
	Copper cylinders of 24,000 pounds initial compression and tables of 1887.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Cannon friction primers (experimental), with modified priming, March, 1890. Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 182 to 186, inclusive. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
	Copper cylinders of 28,000 pounds initial compression and tables of 1887.	
	.....	
	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No 1, Watervliet

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*	*Feet.*
Dec. 29	184	Laflin & Rand's I. K., lot 16; ——; granulation, 2,156. Sample received December 24, 1890.	4 8	Shell (banded), experimental, lot 249.	19 5 11 sand. 20 0	1,515 1,509	No. 1, 35,380	13
Dec. 29	185		4 8		19 5 11 sand. 20 0	1,513 1,510	No. 1, 37,170	15
Dec. 29	186		4 8		19 4 12 sand. 20 0	1,517 1,510 50+½	No. 1, 37,260	11
Dec. 29	187	Laflin & Rand's I. K., lot 17; density, ——; granulation, 2,540. Sample received December 24, 1890.	4 4		19 3 13 sand. 20 0	Lost	No. 1, less than 24,000.	7
Dec. 29	188		4 8		19 4 12 sand. 20 0	1,295 1,287	No. 1, less than 28,000.	9
Dec. 29	189		4 8		19 2 14 sand. 20 0	1,289 1,289	No. 1, less than 24,000.	10
Dec. 29	190	Laflin & Rand's I. K., lot 249; density, 2,540. Sample received December 24, 1890.	4 12		19 3 13 sand. 20 0	1,340 Lost.	No. 1, 22,140	10
Dec. 29	191		4 12		19 2 14 sand. 20 0	1,333 1,332	No. 1, 21,680	10
Dec. 29	192	Laflin & Rand's I.K., lot 18; density, ——; granulation, 2,520. Sample received December 24, 1890.	4 4		19 4 12 sand. 20 0	1,362 1,359	No. 1, 25,400	10
Dec. 29	193		4 12		19 0 1 0 sand. 20 0	1,455 1,447	No. 1, 30,150	13
Dec. 29	194		4 12		19 4 12 sand. 20 0	1,459 1,452 50+½	No. 1, 32,160	13
1891. P. M.								
Jan. 20	195	Du Pont's I. K. H., lot 16; density, 1,725; granulation, 2,524.	4 0		19 1 15 sand. 20 0	.....	.....	14
Jan. 20	196	Laflin & Rand's I. K., lot—; density, ——; granulation, 2,327. Sample received January 16, 1891.	4 4		19 4 12 sand. 20 0	1,428 Lost.	No. 1, 28,300	13
Jan. 20	197		4 8		19 3 13 sand. 20 0	1,475 1,474	No. 1, 29,275	14

Arsenal, at Sandy Hook, N. J., December 29, 1890, and January 20, 1891.

to prove powder.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
From right and rear, 16 miles an hour.	.....	
	Left brake jumped off wheel in recoiling.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Cannon friction primers (experimental), with modified priming, March, 1890. Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 182 to 186, inclusive.
	.....	
	Copper cylinders of 24,000 pounds initial compression and tables of 1887.	
	Copper cylinders of 28,000 pounds initial compression and tables of 1887.	
	Copper cylinders of 24,000 pounds initial compression and tables of 1887.	Cannon friction primers (experimental), with modified priming, March, 1890. Elevation, zero. Copper cylinders of 18,000 pounds initial compression and tables of 1887 used in rounds 190 to 192, inclusive. Fired into field butt, section 1. Copper cylinders of 28,000 pounds initial compression and tables of 1887 used in rounds 193 to 194, inclusive. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
	.....	
	.....	
	.....	
From right and rear, 13 miles an hour.	Warming charge; fired into sand butt....	Gun mounted on Buffington steel field carriage No. 4, with old spiral-spring brakes. Cannon friction primers (experimental), with spiral serrated wire, March, 1890. Fired into field butt, section 1. Copper cylinders of 28,000 pounds initial compression and tables of 1887. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
	Wires of second velocity target not cut...	
	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*	*Feet.*
Jan. 20	198	Laflin & Rand's I. K., lot ——; density, ——; granulation, 2,327. Sample received January 16, 1891.	4 12	Shell (banded), experimental, lot 249.	19 3 13 sand. 20 0	1,504 1,504	No. 1, 31,800	17
Jan. 20	199		4 12		19 4 12 sand. 20 0	1,509 1,509	No. 1, 31,260	16
Jan. 20	200		4 12		19 3 13 sand. 20 0	1,507 1,509	No. 1, 32,910	19
Jan. 20	201		4 12		19 4 12 sand. 20 0	1,503 1,507	No. 1, 31,700	17

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to ascertain cause of

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Shell marked.	Fuse, kind.
			Lbs. Oz.		*Lbs. Oz.*	′		
A. M.	202	Du Pont's I. K. H., lot 16; density, 1.725; granulation, 2,524.	4 0	Shell, lot 249.	19 3 13 sand. 20 0	10	.....	Point percussion.
	203		4 0	Shell, lot 249, fitted with housing for fuse.	19 5 1 0 fuse. 20 5	8	A	

Watervliet Arsenal, at Sandy Hook, N. J., January 20, 1891.

to prove powder.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
From right and rear, 13 miles an hour.	Right brake jumped off wheel in recoiling	Gun mounted on Buffington steel field carriage No. 4, with old spiral-spring brakes. Cannon friction primers (experimental), with spiral serrated wire, March, 1890. Fired into field butt, section 1. Copper cylinders of 28,000 pounds initial compression and tables of 1887. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
	.....	
	Right brake jumped off wheel in recoiling.	
	.....	

Watervliet Arsenal, at Sandy Hook, N. J., January 21, 1891.

premature explosion of point percussion fuse.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
15	From right, 9 miles an hour.	Sighting shot	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Cannon friction primers (experimental), with spiral serrated wire, March, 1890. Firing conducted by the proof officer.
14		Rifle powder removed from fuse before firing, and shell fired into field butt. On recovery it was found that the percussion cap had been exploded.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing.

Date.	No. of fire.	Powder.		Projectile.		Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.		
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*
Feb. 6	204	Du Pont's I. K. H., lot 16; density, 1.725; granulation, 2,524.	4 0	Shell, lot 249.	19 1 15 sand. 20 0	----------	----------
Feb. 6	205	Laflin & Rand's I. K.; density, ——; granulation, 2,716. Received February 3, 1891.	4 4		19 2 14 sand. 20 0	1,411 1,409	No. 1, 27, 580
Feb. 6	206		4 12		19 1 15 sand. 20 0	1,509 1,505	No. 1, 31, 850
Feb. 6	207		4 12		19 3 13 sand. 20 0	1,515 1,507 50+150	No. 1, 31, 080
Feb. 6	208		4 12		19 2 14 sand. 20 0	1,521 1,516	No. 1, 31, 640
P. M.							
Feb. 6	209	Du Pont's I. K. H., lot 16.	4 9		19 4 12 sand. 20 0	----------	----------
Feb. 6	210	Laflin & Rand's I. K.; density, ——; granulation, 2,716. Rec'd Feb. 3, 1891.	4 12		19 3 13 sand. 20 0	1,509 1,508 50+½	No. 1, 32, 240
A. M.							
Feb. 23	211	Du Pont's I. K. H., lot 16; density, 1.725; granulation, 2,524.	4 0		19 2 14 sand. 20 0	1,381	----------
Feb. 23	212	Laflin & Rand's I. K., lot, ——; density, ——; granulation, 2,560. Received Feb. 17, 1891.	4 4		19 4 12 sand. 20 0	1.440 1,447	No. 1, 28, 360
P. M.							
Feb. 23	213	Du Pont's I. K. H., lot 16.	4 0	Shell, experimental, lot 249.	19 1 15 sand. 20 0	1,401	----------
Feb. 23	214	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560. Received Feb. 17, 1891.	4 8		19 4 12 sand. 20 0	1,493 1,486	No. 1, 31, 700
Feb. 23	215		4 12		19 2 14 sand. 20 0	1,535 1,531	No. 1, 33, 780
Feb. 23	216		4 12	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	1,535 1,533	No. 1, 34, 300
Feb. 23	217		4 12		19 3 13 sand. 20 0	1,535 1,526	No. 1, 34, 090
Feb. 23	218		4 12		19 1 15 sand. 20 0	1,536 1,536	No. 1, 39, 100
Feb. 23	219		4 12		19 2 14 sand. 20 0	1,547 1,540 50+½	No. 1, 34, 800

Arsenal, at Sandy Hook, N. J., February 6 and 23, 1891.

to prove powder.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
19	From right and front, 10 miles an hour.	Warming charge; fired to sea.....	
18		Copper cylinders of 18,000 pounds initial compression and tables of 1887.	
23		.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Elevation, zero, Cannon friction primers (experimental), with spiral serrated wire, March, 1890. Fired into field butt, section 1. Copper cylinders of 28,000 pounds initial compression and tables of 1887 used in rounds 206 to 210, inclusive. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
14		.....	
15		Left brake jumped off wheel in recoiling	
14		Warming charge; fired to sea.....	
16		.....	
12	From right and front, 10 miles an hour.	Warming charge; cannon electric primer used.	
13		Copper cylinders of 18,000 pounds initial compression and tables of 1887.	
12		Warming charge; cannon electric primer used; drop phonograph electric gave velocity 1,394 feet.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Cannon friction primers, model 1887. Fired into field butt, section 1. Copper cylinder of 32,000 pounds initial compression and tables of 1890 used in rounds 215 to 219, inclusive. Powder passed inspection. In rounds 211 to 215, inclusive, velocities taken by Lieut. W. W. Gibson, Ordnance Department. In rounds 216 to 219, inclusive, velocities taken by Lieut. C. B. Wheeler, Ordnance Department. Pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
14		Copper cylinders of 28,000 pounds initial compression and tables of 1887.	
19	From front, 11 miles an hour.	Left brake jumped off wheel in recoiling.	
18		.....	
17		Two primers failed	
16		.....	
16		.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing,

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore.	Elevation.	Instrumental velocity, 125 feet from muzzle.
			Lbs. Oz.		*Lbs. Oz.*	*Inches.*	′	*Feet.*
A. M....	220	Du Pont's I. K. H., lot 16; density, 1.725; granulation, 2,524.	4 0	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	21¼	15	1,386
	221	Laflin and Rand's, lot 2; density, 1.710; granulation, 2,250. Received March 2, 1890.	4 4		19 1 15 sand. 20 0		15	1,449 1,450
	222		4 4		19 1 15 sand. 20 0		15	1,428 1,422
	223		4 8		19 1 15 sand. 20 0		15	1,494 1,490
	224		4 8		19 2 14 sand. 20 0		15	1,484 1,480
	225		4 12		19 1 15 sand. 20 0		15	1,548 1,543
								50+150

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to ascertain cause of premature

No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Fuse marked.	Fuse cut at seconds.
		Lbs. Oz.		*Lbs. Oz.*	′		
226	Du Pont's I. K. H., lot 16; density, 1.725; granulation, 2,524.	4 12	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	10	.....	.....
227		4 12	Shell, lot 249, fitted with housing for fuse.	19 15½ with fuse.	10	A	5

Watervliet Arsenal, at Sandy Hook, N. J., March 5, 1891.

to prove powder.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*	From right and front, 23 miles an hour.	Warming charge	
No. 1, 45,040	12		Copper cylinders of 24,000 pounds initial compression and tables of 1887.	Gun mounted on Buffington steel field carriage No. 4, with old spiral-spring brakes.
No. 1, less than 32,000.	12			Cannon friction primers, model 1887.
				Fired to sea.
No. 1, 47,280	13		Copper cylinders of 28,000 pounds initial compression and tables of 1887.	Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 222, 224, and 225.
				Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department.
No. 1, 32,460	13			Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
No. 3, 47,140	15			

Watervliet Arsenal, at Sandy Hook, N. J., March 10, 1891.

explosion of point combination fuse.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.	From front and right, 20 miles an hour.		
15		Sighting shot	Gun mounted on Buffington steel field carriage, No. 4. Old spiral-spring brakes.
16		Rear plunger removed before firing; fuse recovered; spindle broken where perforated by flame passages; spindle cap and cone (around which tube with time composition was wound) found separated from body of fuse; composition in tube ignited; composition in body not ignited.	Cannon friction primers, model 1887.
			Fired into sand butt, section 4.
			Gun sighted by Lieut. O. M. Lissak, Ordnance Department.
			Firing conducted by the proof officer.

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.	Instrumental velocity, 125 feet from muzzle.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Inches.*	′	*Feet.*
Mar. 16	228	Du Pont's I. K. H., lot 16; density, 1.725; granulation, 2,524.	4 0	Shell (banded), experimental, lot 249.	19 5 11 sand. 20 0	.....	0	.....
Mar. 16	229	Laflin & Rand's I. K., lot 3; granulation, 2,363. Received March 11.	4 8		19 2 14 sand. 20 0	.....	0	1,519 1,515 50+1½°
A. M.								
Mar. 17	230	Du Pont's I. K. H., lot 16; density, 1.725; granulation, 2,524.	4 0		19 2 14 sand. 20 0	69.450	0	.....
Mar. 17	231	Laflin & Rand's I. K., lot 3; density, 1.710; granulation, 2,363. Received March 11, 1891.	4 4		18 15 1 1 sand. 20 0		5	1,455 1,448
Mar. 17	232		4 8		19 2 14 sand. 20 0		5	1,495 1,495
Mar. 17	233		4 8		19 1 15 sand. 20 0		5	1,499 1,495
Mar. 17	234		4 12		19 2 14 sand. 20 0		5	1,544 1,539
Mar. 17	235		4 10		19 1 15 sand. 20 0		5	1,525 1,518
Mar. 17	236		4 12		19 2 14 sand. 20 0		5	1,549 1,547

Arsenal, at Sandy Hook, N. J., March 16 and 17, 1891.

to prove powder.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*	From right and rear, 20 miles an hour.	Warming charge; fired into sand butt.	
No. 3, 40, 815	16		.....	
.....	15		Warming charge	Gun mounted on Buffington steel field carriage No. 4, with old spiral-spring brakes.
No. 3, 32, 150	17	From right and front, 8 miles an hour.	.....	Cannon friction primers, model 1887. Fired into field butt, section 2.
No. 3, 34, 570	17		.....	Copper cylinders of 32,000 pounds initial compression and tables of 1890. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department.
No. 3, 33, 450	17		.....	Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
No. 3, 39, 580	20		.....	
No. 3, 34, 975	19	From right	First primer failed.....	
No. 3, 37, 935	20		.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to verify lot

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore.	Elevation.	Instrumental velocity, 125 feet from muzzle.
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Inches.*	′	*Feet.*
Mar. 17	237	Du Pont's I. K. H., lot 16; density, 1.725; granulation, 2,524.	4 0	Shell (banded), experimental, lot 249.	19 3 13 sand. 20 0	69.450	5	.....
Mar. 17	238	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560. Received March 11, 1891.	4 8		19 3 13 sand. 20 0		5	1,482 1,478
Mar. 17	239		4 12		19 3 13 sand. 20 0		5	1,535 1,532
Mar. 17	240		4 12		19 2 14 sand. 20 0		5	1,534 1,531
Mar. 17	241		4 12		19 2 14 sand. 20 0		5	1,540 1,537
Mar. 17	242		4 12		19 3 13 sand. 20 0		5	1,539 1,535
Mar. 17	243		4 12		19 3 13 sand. 20 0		5	1,546 1,539

[Object of firing,

A. M.								
Mar. 17	244	Du Pont's V. A.; density, 1.750; granulation, 2,884. Received March 7, 1891.	4 4	Shell (banded), experimental, lot 249.	19 5 11 sand. 20 0	69.450	5	1,457 1,453
Mar. 17	245		4 8		19 3 13 sand. 20 0		5	1,494 1,493
Mar. 17	246		4 12		19 1 15 sand. 20 0		5	1,541 1,541
Mar. 17	247		4 12		19 4 12 sand. 20 0		5	1,544 Lost.
Mar. 17	248		4 12		19 3 13 sand. 20 0		5	1,546 1,544
Mar. 17	249		4 12		19 4 12 sand. 20 0		5	1,552 1,552 $50+\frac{15}{2}°$

Watervliet Arsenal, at Sandy Hook, N. J., March 17, 1891.

of powder previously proved.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*			
.....	13	From right and front, 8 miles an hour.	.....	
No. 3, 32, 900	14		.....	
No. 3, 34, 140	16		.....	Gun mounted on Buffington steel field carriage No. 4, with old spiral-spring brakes. Cannon friction primers, model 1887. Fired into field butt, section 2. Copper cylinders of 32,000 pounds initial compression and tables of 1890.
No. 3, 34, 380	16		.....	
No. 3, 34, 490	16		.....	
No. 3, 34, 360	17		.....	
No. 3, 35, 200	16		.....	

to prove powder.]

No. 3, 29, 600	14	From right and front, 8 miles an hour.	Copper cylinders of 28,000 pounds initial compression and tables of 1887.	
No. 3, 32, 000	14		Copper cylinders of 28,000 pounds initial compression and tables of 1887.	Cannon friction primers, model 1887. Fired into field butt, section 2.
No. 3, 34, 520	19		Right brake jumped off wheel in recoiling.	Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 246 to 249, inclusive.
No. 3, 36, 400	16		.....	Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department.
No. 3, 35, 280	16		.....	Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
No. 3, 38, 780	16		.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to ascertain cause of

	No. of fire.	Powder.		Projectile.		Elevation.	Fuse marked.
		Kind.	Weight.	Kind.	Weight.		
			Lbs. Oz.		*Lbs. Oz.*	′	
A. M.....	250	DuPont's U. A., density, 1.750; granulation, 2,884. Received March 7.	4 12	Shell (banded), experimental, lot 249.	19 3 13 sand. 20 0	5	.....
P. M.....	251		4 12	Shell, lot 249, fitted with housing for fuse.	19 1 1 0 fuse. 20 1	5	B

Watervliet Arsenal, at Sandy Hook, N. J., March 18, 1891.

premature explosion of point combination fuse.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*	From right and front, 12 miles an hour.		
No. 3, 37,815	16		Sighting shot.	Gun mounted on Buffington steel field carriage No. 4, with old spiral-spring brakes. Cannon friction primers, model 1887. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Fired into sand butt, section 4. Pressures taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer. Gun star-gauged after round 251, March 20, 1891, by Lieut. W. W. Gibson, Ordnance Department.
No. 3, 40,440	17		Shell with fuse recovered. Both plungers removed before firing.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test

Date.	No. of series.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Wind allowance (points left).	Recoil.	Wind, strength and direction.
P. M.				*Lbs. Oz.*		*Lbs. Oz.*	° ′		*Feet.*	
Mar. 25	1	252	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 3 13 sand. 20 0	1 00	¾	14	From left and rear, 9 miles an hour.
Mar. 25	2	253		4 12		19 2 14 sand. 20 0	1 10	¾	16	
Mar. 25	3	254		4 12		19 7 9 sand. 20 0	1 20	1⅓	15	
Mar. 25	4	255		4 12		19 1 15 sand. 20 0	1 20	1⅓	14	
Mar. 25	5	256		4 12		19 1 15 sand. 20 0	1 20	1⅓	13½	
Mar. 25	6	257		4 12		19 1 15 sand. 20 0	1 20	3	14	
Mar. 25	7	258		4 12		19 1 15 sand. 20 0	1 20	3	14½	
Mar. 25	8	259		4 12		19 4 12 sand. 20 0	1 20	3	14	
Mar. 25	9	260		4 12		19 2 14 sand. 20 0	1 20	3	21	
Mar. 25	10	261		4 12		19 2 14 sand. 20 0	1 20	3	14½	
Mar. 25	11	262		4 12		19 1 15 sand. 20 0	1 20	3	14½	
Mar. 25	12	263		4 12		19 4 12 sand. 20 0	1 20	3	14½	
Mar. 25	13	264		4 12		19 3 13 sand. 20 0	1 20	3	13	
Mar. 25	14	265		4 12		19 3 13 sand. 20 0	1 20	3	14	
Mar. 25	15	266		4 12		19 2 14 sand. 20 0	1 20	3	14	

Watervliet Arsenal, at Sandy Hook, N. J., March 25, 1891.

gun for accuracy.]

Distance from center of target.				Distance from center of impact.				Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Vertical.		Horizontal.		Vertical.		Horizontal.			
Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.		
Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*		
....	....	.....	.....	.....	.....	.....	.....	Sighting shot; struck 250 feet in front of target.	
....	....	.....	.....	.....	.....	.....	.....	Sighting shot; struck 150 feet in front of target.	
....	1	23	.....	.....	.....	.....	.....	Sighting shot.....	
....	2½	19	.....	.....	.....	.....	.....	Sighting shot.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral spring brakes.
....	4¾	17	.....	.....	.....	.....	.....	Sighting shot.....	Cannon friction primers, model 1887.
....	4	8	.....	.....	1.1	2	.....	.....	Fired at 1,000-yards target.
....	3¼	4½	.....	.....	.35	.....	1.5	.....	Aimed at upper right-hand corner.
....	2¼	4	.....	.65	.....	.....	2	.....	Sights for 3.2-inch gun used.
....	1½	5¼	.....	1.4	.....	.....	.75	Right brake jumped off wheel in recoiling.	Fired from field-gun platform.
....	3	5¾	.....	.....	.10	.....	.25	.....	
....	2¼	6½	.....	.65	.....	.50	.....	.....	Fired at 1,000-yards target.
....	3¼	7¾	.....	.....	.35	1.75	.....	.....	Aimed at the upper right-hand corner of target.
....	3¾	7½	.....	.....	.85	1.50	.....	.....	Sights for 3.2-inch gun used.
....	2½	4¾	.....	.40	.....	.....	1.25	.....	Fired from field-gun platform.
....	3¼	6	.....	.....	.35	.....	.....	.....	

	Feet.
Center of impact:	
Below	2.9
Right.....	6
Mean vertical deviation from center of impact	0.62
Mean horizontal deviation from center of impact	1.15
Mean deviation from center of impact	1.306
Deviation of center of impact from plane of fire, right.	2.5

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Elevation.	Wind allowance (points left).	Recoil.	Wind, strength and direction.
			Kind.	Weight.	Kind.	Weight.				
P. M.				*Lbs. Oz.*		*Lbs. Oz.*	° ′		*Feet.*	
Mar. 25	16	267	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 1 15 sand. 20 0	1 20	4	18	From left and rear, 9 miles an hour.
Mar. 25	17	268		4 12		19 4 12 sand. 20 0	1 20	4	13½	
Mar. 25	18	269		4 12		19 3 13 sand. 20 0	1 20	4	17	
Mar. 25	19	270		4 12		19 1 15 sand. 20 0	1 20	4	13	
Mar. 25	20	271		4 12		19 1 15 sand. 20 0	1 20	4	12½	
Mar. 25	21	272		4 12		19 2 14 sand. 20 0	1 20	4	13	
Mar. 25	22	273		4 12		19 3 13 sand. 20 0	1 20	4	16	
Mar. 25	23	274		4 12		19 1 15 sand. 20 0	1 20	4	14	
Mar. 25	24	275		4 12		19 1 15 sand. 20 0	1 20	4	20	
Mar. 25	25	276		4 12		19 3 13 sand. 20 0	1 20	4	14	
Mar. 25	26	277		4 12		19 5 11 sand. 20 0	1 20	5	13½	
Mar. 25	27	278		4 12		19 0 1 0 sand. 20 0	1 20	5	13	
Mar. 25	28	279		4 12		19 2 14 sand. 20 0	1 20	5	13½	
Mar. 25	29	280		4 12		19 0 1 0 sand. 20 0	1 20	5	13	

Arsenal, at Sandy Hook, N. J., March 25, 1891—Continued.

gun for accuracy.]

Distance from center of target.				Distance from center of impact.				Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Vertical		Horizontal.		Vertical.		Horizontal.			
Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.		
Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*		
....	3¼	.....	1½	.....	1.575	1.8	.....	.....	
....	2	.....	2¼	.....	.325	1.05	.....	Left edge of slot in carrier ring burred.	
1	....	.....	3½	2.675	.....	.....	.20	Right brake jumped off wheel in recoiling.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes.
....	3	.....	2	.....	1.325	1.3	.....	.....	Fired at 1,000-yards target.
....	1½	.....	2¼	1.75	.....	1.05	.....	Left edge of cam of lever handle burred.	Aimed at the upper right-hand corner of target.
....	1½	.....	2¼	.175	.....	1.05	.....	.....	Cannon friction primers, model of 1887.
....	3½	.....	2½	.....	1.825	.80	.....	.....	Sights for 3.2-inch gun used.
....	1	.....	5	.675	.....	.....	1.7	.....	Fired from field-gun platform.
....	1¼	.....	7	.425	.....	.....	3.7	.....	Feet.
....	¾	.....	4¾	.925	.....	.....	1.45	.....	Center of impact:
....	5¾	.....	7¼	.....	3.30	3.625	.....	.....	Below 1.675
....	4½	.....	13½	.....	2.05	.....	2.375	.....	Left 3.3
....	2½	.....	7	.....	.05	3.875	.....	.....	Mean vertical deviation from center of impact.... 1.01
....	2½	.....	14½	.....	.05	.....	3.625	.....	Mean horizontal deviation from center of impact. 1.41
									Mean deviation from center of impact..... 1.73
									Deviation of center of impact from plane of fire, right 0.7
									Fired at 1,000-yards target.
									Aimed at the upper right-hand corner of target.
									Cannon friction primers, model 1887.
									Sights of 3.2-inch gun used.
									Fired from field-gun platform.
									Feet.
									Center of impact:
									Below 2.45
									Left 10.875

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Elevation.	Wind allowance (points left).	Recoil.	Wind, strength and direction.
			Kind.	Weight.	Kind.	Weight.				
P. M.				*Lbs. Oz.*		*Lbs. Oz.*	° ′		*Feet.*	
Mar. 25	30	281	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 4 12 sand. 20 0	1 20	5	14	From left and rear, 9 miles an hour.
Mar. 25	31	282		4 12		19 1 15 sand. 20 0	1 20	5	14	
Mar. 25	32	283		4 12		19 3 13 sand. 20 0	1 20	5	15	
Mar. 25	33	284		4 12		19 3 13 sand. 20 0	1 20	5	14	
Mar. 25	34	285		4 12		19 0 1 0 sand. 20 0	1 20	5	14	
Mar. 25	35	286		4 12		19 0 1 0 sand. 20 0	1 20	5	14	
Mar. 26	36	287		4 12		19 1 15 sand. 20 0	1 50	1	17	
Mar. 26	37	288		4 12		19 1 15 sand. 20 0	2 05	.....	17	
Mar. 26	38	289		4 12		19 4 12 sand. 20 0	2 20	½	18	From rear, 8 miles an hour.
Mar. 26	39	290		4 12		19 3 13 sand. 20 0	2 20	½	17	
Mar. 26	40	291		4 12		19 2 14 sand. 20 0	2 20	½	17	
Mar. 26	41	292		4 12		19 4 12 sand. 20 0	2 20	½	18	
Mar. 26	42	293		4 12		19 2 14 sand. 20 0	2 20	½	16	
Mar. 26	43	294		4 12		19 4 12 sand. 20 0	2 20	½	17	

Arsenal, at Sandy Hook, N. J., March 25 and 26, 1891.

gun for accuracy.]

Distance from center of target.				Distance from center of impact.				Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Vertical.		Horizontal.		Vertical.		Horizontal.			
Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.		
Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*		
¼	....	.....	10	2.70	.....	.875	.....	.....	
.....	1¾	.....	12	.70	.....	.....	1.125	.....	
.....	¾	.....	13½	1.70	.....	.....	2.625	.....	
.....	3	.....	12	.....	.55	.....	1.125	.....	
.....	1	.....	9	1.45	.....	1.875	.....	First primer failed.....	
.....	3	.....	10¼	.....	.55	.625	.....	First primer failed.....	
.....	....	.....	.....	.....	.....	.....	.....	Sighting shot.....	
.....	....	.....	.....	.....	.....	.....	.....	Sighting shot.....	
.....	7	.....	4½	1.425	.....	.....	1.90	.....	
.....	9¾	.....	3½	.....	1.325	.....	.90	.....	
.....	8	.....	1	.425	.....	1.60	.....	.....	
.....	7¾	.....	2	.675	.....	.60	.....	.....	
.....	6	.....	2¼	2.425	.....	.35	.....	.....	
.....	9½	.....	.....	.....	.825	2.60	.....	.....	

Feet.

Mean vertical deviation from center of impact... 1.31

Mean horizontal deviation from center of impact. 2.175

Mean deviation from center of impact..... 2.539

Deviation of center of impact from plane of fire, right 0.6

Gun sighted by Lieut. O. M. Lissak, Ordnance Department.

Target observed by Lieut. C. B. Wheeler, Ordnance Department.

Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.

Gun mounted on Buffington steel field carriage No. 4, with old spiral-spring brakes.

Cannon friction primers, model 1887.

Fired from platform on fort wall, at 1 mile target.

Aimed at the upper left-hand corner.

Peep rear sight and cross-hair front sight used.

Feet.

Center of impact:
Below 8.425
Left 2.60

Mean vertical deviation from center of impact... 1.06

Mean horizontal deviation from center of impact 1.2

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Elevation.	Wind allowance (points left).	Recoil.	Wind, strength and direction.
			Kind.	Weight.	Kind.	Weight.				
P. M.				*Lbs. Oz.*		*Lbs. Oz.*	° ′		*Feet.*	
Mar. 26	44	295	Laflin & Rand's L. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 3 13 sand. 20 0	2 20	½	16	From rear, 8 miles an hour.
Mar. 26	45	296		4 12		19 4 12 sand. 20 0	2 20	½	17	
Mar. 26	46	297		4 12		19 4 12 sand. 20 0	2 20	½	18	
Mar. 26	47	298		4 12		19 3 13 sand. 20 0	2 20	½	17	
Mar. 31	48	299		4 12		19 2 14 sand. 20 0	2 20	.....	17	
Mar. 31	49	300		4 12		19 5 11 sand. 20 0	2 28	.....	17	
Mar. 31	50	301		4 12		19 4 12 sand. 20 0	2 28	.....	18	From left, 22 miles an hour.
Mar. 31	51	302		4 12		19 1 15 sand. 20 0	2 28	.....	17	
Mar. 31	52	303		4 12		19 3 13 sand. 20 0	2 28	.....	17	
Mar. 31	53	304		4 12		19 4 12 sand. 20 0	2 28	.....	18	
Mar. 31	54	305		4 12		19 2 14 sand. 20 0	2 28	.....	17	
Mar. 31	55	306		4 12		19 4 12 sand. 20 0	2 28	.....	17	
Mar. 31	56	307		4 12		19 2 14 sand. 20 0	2 28	.....	18	
Mar. 31	57	308		4 12		19 4 12 sand. 20 0	2 28	.....	18	

Arsenal, at Sandy Hook, N. J., March 26 and 31, 1891.

gun for accuracy.]

Distance from center of target.				Distance from center of impact.				Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Vertical.		Horizontal.		Vertical.		Horizontal.			
Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.		
Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*		
.....	8.25	.....	3.75	.175	.....	.....	1.15	.....	Feet. Mean deviation from center of impact..... 1.6 Deviation of center of impact from plane of fire, right 10.8
.....	11.25	.....	1.75	.....	2.825	.85	.....	.....	
.....	8.75	.....	3.50	.....	.325	.....	.90	.....	Gun sighted by Lieut. O. M. Lissak, Ordnance Department. Target observed by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by the proof officer.
.....	8.25	.....	3.75	.175	.....	.....	1.15	.....	
.....	.....	.....	.....	.....	.....	.....	.....	Sighting shot; struck in front of target.	
.....	2.75	13.25	.....	.....	1.475	.65	.....	.....	
.....	.50	9.50	.....	.775	.....	.....	3.1	.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Fired at 1-mile target. Aimed at upper left-hand corner. Cannon friction primers, model 1887. Fired from platform on fort wall. Sights for 3.6-inch rifle used: peep rear sight and cross-hair trunnion sight. Feet. Center of impact: Below ..... 1.275 Right.....12.6 Mean vertical deviation from center of impact..... 1.735 Mean horizontal deviation from center of impact. 1.8 Mean deviation from center of impact..... 2.5
.....	.....	11.00	.....	1.275	.....	.....	1.6	.....	
.....	.75	12.25	.....	.525	.....	.....	.35	.....	
.....	7.00	14.50	.....	.....	5.725	1.90	.....	.....	
1.50	.....	13.00	.....	2.775	.....	.40	.....	.....	
1.00	.....	10.75	.....	2.275	.....	.....	1.85	.....	
.....	2.75	17.00	.....	.....	1.475	4.4	.....	.....	
.....	.75	14.25	.....	.525	.....	1.65	.....	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Elevation.	Wind allowance (points left).	Recoil.	Wind, strength and direction.
			Kind.	Weight.	Kind.	Weight.				
P. M.				*Lbs. Oz.*		*Lbs. Oz.*	° ′		*Feet.*	
Mar. 31	58	309	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 4 12 sand. 20 0	2 28	.....	18	From left, 22 miles an hour.
Mar. 31	59	310		4 12		19 2 14 sand. 20 0	2 32	1	18	
Mar. 31	60	311		4 12		19 0 1 0 sand. 20 0	2 32	1	17	
Mar. 31	61	312		4 12		19 2 14 sand. 20 0	2 32	1	18	
Mar. 31	62	313		4 12		19 5 11 sand. 20 0	2 32	1	17	
Mar. 31	63	314		4 12		19 4 12 sand. 20 0	2 32	1	17	
Mar. 31	64	315		4 12		19 2 14 sand. 20 0	2 32	1	18	
Mar. 31	65	316		4 12		19 2 14 sand. 20 0	2 32	1	17	
Mar. 31	66	317		4 12		19 2 14 sand. 20 0	2 32	1	17	
Mar. 31	67	318		4 12		19 2 14 sand. 20 0	2 32	1	18	
Mar. 31	68	319		4 12		19 1 15 sand. 20 0	2 32	1	18	

Watervliet Arsenal, at Sandy Hook, N. J., March 31, 1891.

gun for accuracy.]

Distance from center of target.				Distance from center of impact.				Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc.. and metrological data.	General remarks.
Vertical.		Horizontal.		Vertical.		Horizontal.			
Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.		
Ft.	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*		Feet.
.....	.75	10.50	.....	.525	.....	.....	2.10	.....	Deviation of center of impact from plane of fire, right 32.6
8.50	....	2.25	.....	4.15	.....	1.775	.....	.....	
.....	1.50	.....	1.75	.....	5.85	.....	2.225	.....	Gun mounted on Buffiington steel field carriage No. 4. Old spiral-spring brakes. Fired at 1-mile target. Aimed at upper left-hand corner.
3.00	....	1.50	.....	.....	1.35	1.025	.....	.....	Cannon friction primers, model 1887. Fired from platform on fort wall.
6.25	....	.....	3.00	1.90	.....	.....	3.475	First primer failed.....	Sights for 3.6-inch rifle used: peep rear sight, cross-hair front sight.
									Feet.
5.00	....	2.75	.....	.65	.....	2.275	.....	.....	Center of impact: Above..... 4.35 Right..... .475 Mean vertical deviation from center of impact.... 2.95
6.00	....	.....	.....	1.65	.....	.....	.475	.....	Mean horizontal deviation from center of impact. 1.425 Mean deviation from center of impact..... 3.276
.....	....	.....	.....	.....	4.35	.....	.475	.....	Deviation of center of impact from plane of fire, right 33.495
10.75	....	.....	.....	6.4	.....	.....	.475	.....	Gun sighted by Lieut. O. M. Lissak, Ordnance Department. Target observed by Lieut. C. D. Wheeler, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
2.00	....	1.50	.....	.....	2.35	1.025	.....	.....	
3.50	....	1.50	.....	.....	.85	1.025	.....	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*	*Inches.*	*Feet.*	*Pounds.*
Apr. 1	320	Du Pont's I. K. H., lot 16; density, 1.725; granulation, 2,524.	4 0	Shell rebanded.	19 2 14 sand. 20 0	69.450	.....	.....
Apr. 1	321	Laflin & Rand's I. K., lot 2; density, 1.710; granulation, 2,200. Received March 31, 1891.	4 8		19 2 14 sand. 20 0		14.87 14.82	No. 3, 32, 150
Apr. 1	322		4 12		19 3 13 sand. 20 0		15.39 15.35	No. 3, 35, 460
Apr. 1	323		4 12		19 2 14 sand. 20 0		15.43 15.37	No. 3, 34, 785
Apr. 1	324		4 12		19 2 14 sand. 20 0		15.39 Lost.	No. 3, 35, 500
Apr. 1	325		4 12		18 14 1 2 sand. 20 0		15.41 15.35	No. 3, 35, 975
Apr. 1	326		4 12		19 5 11 sand. 20 0		15.30 15.35	No. 3, 34, 700
Apr. 1	327	Laflin & Rand's I. K., lot 3; density, 1.710; granulation, 2,165. Received March 31, 1891.	4 8		18 14 1 2 sand. 20 0		14.91 14.83	No. 3, 32, 540
Apr. 1	328		4 12		18 14 1 2 sand. 20 0		15.33 15.26	No. 3, 34, 380
Apr. 1	329		4 12		19 1 15 sand. 20 0		15.47 15.40	No. 3, 44, 860
P. M. Apr. 1	330	Du Pont's I. K. H., lot 16.	4 0		19 1 15 sand. 20 0		.....	.....
Apr. 1	331	Laflin & Rand's I. K., lot 3; density, 1.710; granulation, 2,165. Received March 31, 1891.	4 12		19 11 5 sand. 20 0		15.33 15.24	No. 3, 33, 880
Apr. 1	332		4 12		19 0 1 0 sand. 20 0		15.31 15.28	No. 3, 35, 420
Apr. 1	333		4 12		19 3 13 sand. 20 0		15.28 15.25	No. 3, 34, 160
Apr. 1	334		4 12		18 15 1 1 sand. 20 0		15.30 15.28	No. 3, 34, 955

Watervliet Arsenal, at Sandy Hook, N. J., April 1, 1891.

to prove powder.]

Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.		
14	Warming charge.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Elevation, zero. Cannon friction primers, model 1887. Fired into sand butt, section 2. Copper cylinders of 32,000 pounds initial compression and tables of 1890.
15½	.....	
15	.....	
14	.....	
15	.....	
14	Strap buckled around breech and rod of elevating device before this round.	
13½	.....	
13	.....	
15	Guiding fork on top of elevating screw beginning to bend; strap removed before this round.	
14	.....	
12	Warming charge.....	
15	.....	
15	.....	
15	.....	
16	.....	Cannon friction primers, model 1887. Fired into field butt, section 2. Copper cylinders of 32,000 pounds initial compression and tables of 1890.
17	Right brake jumped off wheel in recoiling.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Inches.*	*Feet.*	*Pounds.*
Apr. 1	335	Laflin & Rand's I. K., lot 4; density, 1.710; granulation, 2,135. Received March 31, 1891.	4 12	Shell rebanded.	19 1 15 sand. 20 0	69.450	Lost.	No. 3, 36, 955
Apr. 1	336		4 12		19 4 12 sand. 20 0		15.33 15.31	No. 3, 36, 340
Apr. 1	337		4 12		19 1 15 sand. 20 0		15.40 15.40	No. 3, 37, 500
Apr. 1	338		4 12		19 2 14 sand. 20 0		15.45 15.44	No. 3, 39, 420
Apr. 1	339		4 12		19 4 12 sand. 20 0		15.40 15.41	No. 3, 36, 000
Apr. 1	340		4 12		19 1 15 sand. 20 0		15.39 15.36	No. 3. 36, 080
Apr. 1	341	Laflin & Rand's I. K., lot 5; density, 1.710; granulation, 2,254. Received March 31, 1891.	4 12		18 14 1 2 sand. 20 0		1,540 1,534	No. 3, 35, 100
Apr. 1	342		4 12		19 0 1 0 sand. 20 0		1,536 1,529	No. 3, 34, 280
Apr. 1	343		4 12		19 1 15 sand. 20 0		1,537 1,531	No. 3, 34, 300
Apr. 1	344		4 12		19 0 1 0 sand. 20 0		1,537 1,537	No. 3, 37, 615
Apr. 1	345		4 12		19 3 13 sand. 20 0		1,533 1,531	No. 3, 37, 400
Apr. 1	346		4 12		19 0 1 0 sand. 20 0		1,533 1,527	No. 3, 34, 750
Apr. 1	347	Laflin & Rand's I. K.; lot 6; density, 1.710; granulation, 2,300. Received March 31, 1891.	4 12		19 12 4 sand. 20 0		1,514 1,512	No. 3, 34, 240
Apr. 1	348		4 12		19 2 14 sand. 20 0		1,526 1,522	No. 3, 35, 460
Apr. 1	349		4 12		19 1 15 sand. 20 0		1,526 Lost.	No. 3, 35, 800

Arsenal, at Sandy Hook, N. J., April 1, 1891—Continued.

to prove powder.]

Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.		
15		
15		
14		Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt, section 2. Copper cylinders of 32,000 pounds initial compression and tables of 1890.
14		
15		
15		
15		
15		
18	Right brake jumped off wheel in recoiling.	
15		
16		Cannon friction primers, model 1887. Fired into field butt, section 2. Copper cylinders of 32,000 pounds initial compression and tables 1890. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
15		
15		
17	Right brake jumped off wheel in recoiling.	
15		
14		

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Inches.*	*Feet.*	*Pounds.*
Apr. 1	350	Laflin & Rand's I. K., lot 6; density, 1.710; granulation, 2,300. Received March 31, 1891.	4 12	Shell rebanded.	19 2 14 sand. 20 0		1,522 1,517	No. 3, 35, 825
Apr. 1	351		4 12		19 3 13 sand. 20 0		1,529 1,522	No. 3, 35, 910
A. M.								
Apr. 2	352	Du Pont's I. K. H., lot 16.	4 0		19 3 13 sand. 20 0		.....	.....
Apr. 2	353	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,320. Received March 31, 1891.	4 12		19 4 12 sand. 20 0		1,536 1,528	No. 3, 35, 460
Apr. 2	354		4 12		19 4 12 sand. 20 0		1,532 1,526	No. 3, 38, 340
Apr. 2	355		4 12		19 2 14 sand. 20 0		1,537 1,531	No. 3, 41, 220.
Apr. 2	356		4 12		19 1 15 sand. 20 0		1,530 1,524	No. 3, 34, 750
Apr. 2	357		4 12		19 1 15 sand. 20 0	69.450	1,531 1,526	No. 3, 37, 830
Apr. 2	358		4 12		19 1 15 sand. 20 0		1,547 1,543 50+½	No. 3, 39, 855
P. M.								
Apr. 7	359	Du Pont's I. K. H., lot 16.	4 0		19 1 15 sand. 20 0		.....	.....
Apr. 7	360	Laflin & Rand's I. K., lot 6 and 7, mixed; granulation, 2,360; density, 1.710.	4 12	Shell (banded), experimental, lot 249.	19 4 12 sand. 20 0		1,535 1,529	No. 3, 33, 810
Apr. 7	361		4 12		19 3 13 sand. 20 0		1,534 1,530	No. 3, 34, 160
Apr. 7	362		4 12		19 1 15 sand. 20 0		1,531 1,527	No. 3, 33, 800
Apr. 7	363		4 12		19 1 15 sand. 20 0		1,536 1,531	No. 3, 34, 650
Apr. 7	364		4 12		19 2 14 sand. 20 0		1,532 1,536	No. 3, 34, 920

Watervliet Arsenal, at Sandy Hook, N. J., April 1 to 7, 1891.

to prove powder.]

Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.		
16	.....	
16	.....	
13	Warming charge	
15	.....	
17	Right brake jumped off wheel in recoiling.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Cannon friction primers, model 1887. Fired into field butt, section 2. Copper cylinders of 32,000 pounds initial compression and tables of 1890.
15	.....	
15	.....	
15	.....	
15	.....	
15	Warming charge	
15	.....	
18	Left brake jumped off wheel in recoiling.	Elevation, zero. Cannon friction primers, model 1887. Fired into field butt. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
15	.....	
18	Right brake jumped off wheel in recoiling.	
15	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test Merriam

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Wind allowance, points right.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs. Oz.*	° ′		*Pounds.*
Apr. 13	365	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249, altered to receive fuse.	18 1 1 1 fuse. 12 19 14	2 20	.....	No. 3, 34,400

[Object of firing, to test

Apr. 15	366	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	5 20	½	.....

Watervliet Arsenal, at Sandy Hook, N. J., April 13 and 15, 1891.

base percussion fuse (automatic).]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			Gun mounted on Buffington steel field carriages No. 4, with old spiral-spring brakes. Cannon friction primers, model 1887. Fired at 1-mile target. Uncompressed copper cylinders and tables of 1890. Firing conducted by the proof officer.
16	.....	Fuse stamped No. 55 on base; shell broke up in gun; fuse not recovered.	

gun for accuracy.]

17	From right and rear, 7 miles an hour.	Sighting shot; miss to the left	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Cannon friction primers, model 1887. Fired at 3,000-yards target. Fired from platform on fort wall. Sighted at left edge of target. Gun sighted by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Including sand.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
			Kind.	Weight.	Kind.	Weight.			
A. M.				*Lbs. Oz.*		*Pounds.*	*Lbs. Oz.*	*Feet.*	*Pounds.*
Apr. 16	1	367	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	14	.....	No. 3, 35, 125
Apr. 16	2	368		4 12		20	14	.....	.....
Apr. 16	3	369		4 12		20	12	.....	.....
Apr. 16	4	370		4 12		20	15	.....	.....
Apr. 16	5	371		4 12		20	15	.....	.....
Apr. 16	6	372		4 12		20	13	.....	.....
Apr. 16	7	373		4 12		20	11	.....	.....
Apr. 16	8	374		4 12		20	1 2	.....	.....
Apr. 16	9	375		4 12		20	15	.....	.....
Apr. 16	10	376		4 12		20	13	.....	No. 3, 34, 933
Apr. 16	11	377		4 12		20	14	.....	.....
Apr. 16	12	378		4 12		20	15	.....	.....
Apr. 16	13	379		4 12		20	14	.....	.....
Apr. 16	14	380		4 12		20	15	.....	.....
Apr. 16	15	381		4 12		20	1 1	.....	.....
Apr. 16	16	382		4 12		20	1 2	.....	.....
Apr. 16	17	383		4 12		20	12	.....	.....
Apr. 16	18	384		4 12		20	13	.....	.....
Apr. 16	19	385		4 12		20	13	.....	.....
Apr. 16	20	386		4 12		20	12	.....	.....
Apr. 16	21	387		4 12		20	14	.....	No. 3, 34, 700
Apr. 16	22	388		4 12		20	13	.....	.....
Apr. 16	23	389		4 12		20	14	.....	.....
Apr. 16	24	390		4 12		20	15	.....	.....
Apr. 16	25	391		4 12		20	14	.....	.....
Apr. 16	26	392		4 12		20	15	.....	.....
Apr. 16	27	393		4 12		20	13	.....	.....
Apr. 16	28	394		4 12		20	12	.....	.....
Apr. 16	29	395		4 12		20	13	.....	.....
Apr. 16	30	396		4 12		20	15	.....	.....
Apr. 16	31	397		4 12		20	13	.....	.....
Apr. 16	32	398		4 12		20	14	.....	.....
Apr. 16	33	399		4 12		20	15	.....	.....
Apr. 16	34	400		4 12		20	15	.....	.....
Apr. 16	35	401		4 12		20	14	.....	.....
Apr. 16	36	402		4 12		20	12	.....	.....
Apr. 16	37	403		4 12		20	13	.....	.....
Apr. 16	38	404		4 12		20	14	.....	.....
P. M.									
Apr. 16	39	405	Laflin & Rand's I. K., lot 1, mixed; density, 1.710; granulation, 2,560.	4 12		20	10	.....	.....
Apr. 16	40	406		4 12		20	13	.....	.....
Apr. 16	41	407		4 12		20	14	.....	.....
Apr. 16	42	408		4 12		20	15	.....	No. 3, 35, 835
Apr. 16	43	409		4 12		20	14	.....	.....
Apr. 16	44	410		4 12		20	14	.....	.....
Apr. 16	45	411		4 12		20	12	.....	.....
Apr. 16	46	412		4 12		20	15	.....	.....
Apr. 16	47	413		4 12		20	15	.....	.....
Apr. 16	48	414		4 12		20	13	.....	.....
Apr. 16	49	415		4 12		20	11	.....	.....
Apr. 16	50	416		4 12		20	14	.....	No. 3, 35, 527
Apr. 16	51	417		4 12		20	14	.....	.....
Apr. 16	52	418		4 12		20	13	.....	.....
Apr. 16	53	419		4 12		20	13	.....	.....
Apr. 16	54	420		4 12		20	12	.....	.....
Apr. 16	55	421		4 12		20	13	.....	.....
Apr. 16	56	422		4 12		20	11	.....	.....
Apr. 16	57	423		4 12		20	14	.....	.....
Apr. 16	58	424		4 12		20	14	.....	.....
Apr. 16	59	425		4 12		20	13	.....	.....
Apr. 16	60	426		4 12		20	14	.....	.....
Apr. 16	61	427		4 12		20	13	.....	No. 3, 34, 400
Apr. 16	62	428	Laflin & Rand's I. K., lot 1, mixed; density, 1.710; granulation, 2,560.	4 12		20	13	.....	.....
Apr. 16	63	429		4 12		20	12	.....	.....
Apr. 16	64	430		4 12		20	13	.....	.....
Apr. 16	65	431		4 12		20	1 0	.....	.....
Apr. 16	66	432		4 12		20	12	.....	.....
Apr. 16	67	433		4 12		20	10	.....	.....

Watervliet Arsenal, at Sandy Hook, N. J., April 16, 1891.

gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Right brake jumped off wheel in recoiling	
Right brake jumped off wheel in recoiling	
Left brake jumped off wheel in recoiling	
Left brake jumped off wheel in recoiling	
Assembling nut in journal box of elevating gear tightened after this round. Nut of arbor of elevating gear tightened after this rouud.	Gun mounted on Buffington steel field carriage No. 4.
	Elevation, zero.
	Spiral-spring brake used on left wheel in rounds 367 to 372, inclusive; after which bow-spring brake was used.
	Spiral spring brake used on right wheel in rounds 367 to 373, inclusive; after which bow-spring brake was used.
	Fired into field butt.
	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
Left brake jumped off wheel in recoiling	Time occupied in firing 10 rounds (398 to 407), 8 minutes.
First primer failed to ignite charge	
First primer failed to ignite charge	
First primer failed to ignite charge	
Gun hung fire	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test

Date.	No. of series.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Including sand.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
P. M.				*Lbs. Oz.*		*Pounds.*	*Lbs. Oz.*	*Feet.*	*Pounds.*
Apr. 16	68	434	Laflin & Rand's I. K., lot 1, mixed; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	11	.....	.....
Apr. 16	69	435		4 12		20	1 0	.....	.....
Apr. 16	70	436		4 12		20	12	.....	.....
Apr. 16	71	437		4 12		20	13	.....	.....
Apr. 16	72	438		4 12		20	11	.....	.....
Apr. 16	73	439		4 12		20	13	.....	.....
Apr. 16	74	440		4 12		20	14	.....	No. 3, 35, 600
Apr. 16	75	441		4 12		20	15	.....	.....
Apr. 16	76	442		4 12		20	14	.....	.....
Apr. 16	77	443		4 12		20	1 0	.....	.....
Apr. 16	78	444		4 12		20	12	.....	.....
Apr. 16	79	445		4 12		20	13	.....	.....
Apr. 16	80	446		4 12		20	11	.....	.....
Apr. 16	81	447		4 12		20	9	.....	.....
Apr. 16	82	448		4 12		20	10	.....	.....
Apr. 16	83	449		4 12		20	10	.....	.....
Apr. 16	84	450		4 12		20	12	.....	No. 3, 35, 700
Apr. 16	85	451		4 12		20	15	.....	.....
Apr. 16	86	452		4 12		20	15	.....	.....
Apr. 16	87	453		4 12		20	14	.....	.....
Apr. 16	88	454		4 12		20	12	.....	.....
Apr. 16	89	455		4 12		20	1 1	.....	.....
Apr. 16	90	456		4 12		20	15	.....	.....
Apr. 16	91	457		4 12		20	14	.....	.....
A. M.									
Apr. 23	92	458		4 12		20	14	1,543 / 1,541	No. 3, 37, 300
Apr. 23	93	459		4 12		20	14	.....	.....
Apr. 23	94	460		4 12		20	14	.....	.....
Apr. 23	95	461		4 12		20	13	.....	.....
Apr. 23	96	462		4 12		20	13	.....	.....
Apr. 23	97	463		4 12		20	14	.....	.....
Apr. 23	98	464		4 12		20	11	.....	.....
Apr. 23	99	465		4 12		20	12	.....	.....
Apr. 23	100	466	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12		20	15	.....	.....
Apr. 23	101	467		4 12		20	15	.....	.....
Apr. 23	102	468		4 12		20	12	.....	.....
Apr. 23	103	469		4 12		20	14	.....	No. 3, 35, 700
Apr. 23	104	470		4 12		20	13	.....	.....
Apr. 23	105	471		4 12		20	11	.....	.....
Apr. 23	106	472		4 12		20	15	.....	.....
Apr. 23	107	473		4 12		20	14	.....	.....
Apr. 23	108	474		4 12		20	13	.....	.....
Apr. 23	109	475		4 12		20	12	.....	.....
Apr. 23	110	476		4 12		20	14	.....	.....
Apr. 23	111	477		4 12		20	15	.....	.....
Apr. 23	112	478		4 12		20	13	.....	.....
Apr. 23	113	479		4 12		20	14	.....	No. 3, 34, 980
Apr. 23	114	480		4 12		20	15	.....	.....
Apr. 23	115	481		4 12		20	14	.....	.....
Apr. 23	116	482		4 12		20	13	.....	.....
Apr. 23	117	483		4 12		20	15	.....	.....
Apr. 23	118	484		4 12		20	14	.....	.....
Apr. 23	119	485		4 12		20	13	.....	.....
Apr. 23	120	486		4 12		20	12	.....	.....
Apr. 23	121	487		4 12		20	10	.....	.....
Apr. 23	122	488		4 12		20	1 0	.....	.....
Apr. 23	123	489		4 12		20	15	.....	No. 3, 41, 720
Apr. 23	124	490		4 12		20	14	.....	.....
Apr. 23	125	491		4 12		20	12	.....	.....
Apr. 23	126	492		4 12		20	11	.....	.....
Apr. 23	127	493		4 12		20	13	.....	.....
Apr. 23	128	494		4 12		20	14	.....	No. 3, 34, 900
Apr. 23	129	495		4 12		20	15	.....	.....
Apr. 23	130	496		4 12		20	14	.....	.....
Apr. 23	131	497		4 12		20	15	.....	.....
Apr. 23	132	498		4 12		20	14	.....	.....
Apr. 23	133	499		4 12		20	15	.....	.....
Apr. 23	134	500		4 12		20	14	.....	.....
Apr. 23	135	501		4 12		20	14	.....	.....
Apr. 23	136	502		4 12		20	15	.....	.....
Apr. 23	137	503		4 12		20	14	.....	.....

Watervliet Arsenal, at Sandy Hook, N. J., April 16 and 23, 1891.

gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	Gun mounted on Buffington steel field carriage No. 4. Bow sprin g brakes.
	Cannon friction primers, model 1887.
	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
First cartridge tried was too large to enter chamber.	Fired into sand butt.
First cartridge too large to enter chamber.	
	Cannon friction primers, model 1887.
	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
	Elevation, zero.
	Fired into field butt.
	Breech mechanism worked satisfactorily throughout the firing.
	Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, board for testing of rifled cannon.
	Gun star-gauged after round 457, April 22, 1891, by Lieut. W. W. Gibson, Ordnance Department.
Assembling nut in journal-box of elevating gear tightened.	Elevation, zero.
	Cannon friction primers, model 1887.
	Fired into field butt.
	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
First cartridge was too large to enter chamber ..	
	Cannon friction primers, model 1887.
	Elevation, zero.
	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
	Fired into field butt.
First primer failed to ignite charge.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

Object of firing, to test

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Including sand.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
			Kind.	Weight.	Kind.	Weight.			
A. M.				*Lbs. Oz.*		*Pounds.*	*Lbs. Oz.*	*Feet.*	*Pounds.*
Apr. 23	138	504	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	15	.....	.....
Apr. 23	139	505		4 12		20	15	.....	.....
Apr. 23	140	506		4 12		20	13	.....	.....
Apr. 23	141	507		4 12		20	12	.....	.....
Apr. 23	142	508		4 12		20	13	.....	.....
Apr. 23	143	509		4 12		20	14	.....	.....
Apr. 23	144	510		4 12		20	15	.....	.....
Apr. 28	145	511		4 12		20	15	.....	.....
Apr. 28	146	512		4 12		20	14	.....	No. 3, 35, 150
Apr. 28	147	513		4 12		20	12	.....	.....
Apr. 28	148	514		4 12		20	13	.....	.....
Apr. 28	149	515		4 12		20	12	.....	.....
Apr. 28	150	516		4 12		20	11	.....	.....
Apr. 28	151	517		4 12		20	13	.....	.....
Apr. 28	152	518		4 12		20	15	.....	.....
Apr. 28	153	519		4 12		20	1 0	.....	.....
Apr. 28	154	520		4 12		20	15	.....	.....
Apr. 28	155	521		4 12		20	14	.....	.....
Apr. 28	156	522		4 12		20	11	.....	.....
Apr. 28	157	523		4 12		20	14	.....	.....
Apr. 28	158	524		4 12		20	15	.....	.....
Apr. 28	159	525		4 12		20	14	.....	.....
Apr. 28	160	526		4 12		20	14	.....	.....
Apr. 28	161	527		4 12		20	13	.....	.....
Apr. 28	162	528		4 12		20	13	.....	.....
Apr. 28	163	529		4 12		20	13	.....	.....
Apr. 28	164	530		4 12		20	14	.....	.....

[Object of firing, to test repairs made

P. M.									
Apr. 29	.....	531	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	11	.....	.....
Apr. 29	.....	532		4 12		20	13	.....	.....
Apr. 29	.....	533		4 12		20	13	.....	.....
Apr. 29	.....	534		4 12		20	14	.....	.....
Apr. 29	.....	535		4 12		20	12	.....	.....

[Object of firing, to test

P. M.									
Apr. 30	165	536	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	14	.....	.....
Apr. 30	166	537		4 12		20	15	.....	.....
Apr. 30	167	538		4 12		20	15	.....	.....
Apr. 30	168	539		4 12		20	13	.....	.....
Apr. 30	169	540		4 12		20	12	.....	.....
Apr. 30	170	541		4 12		20	1 0	.....	.....
Apr. 30	171	542		4 12		20	1 0	.....	.....
Apr. 30	172	543		4 12		20	1 0	.....	.....
Apr. 30	173	544		4 12		20	12	.....	.....
Apr. 30	174	545		4 12		20	14	.....	.....
Apr. 30	175	546		4 12		20	15	.....	.....
Apr. 30	176	547		4 12		20	15	.....	.....
Apr. 30	177	548		4 12		20	13	.....	.....
Apr. 30	178	549		4 12		20	1 2	.....	.....
Apr. 30	179	550		4 12		20	14	.....	.....
Apr. 30	180	551		4 12		20	15	.....	.....
Apr. 30	181	552		4 12		20	14	.....	.....
Apr. 30	182	553		4 12		20	12	.....	.....
Apr. 30	183	554		4 12		20	13	.....	.....
Apr. 30	184	555		4 12		20	12	.....	No. 3, 35, 150
Apr. 30	185	556		4 12		20	14	.....	.....
Apr. 30	186	557		4 12		20	15	.....	.....
Apr. 30	187	558		4 12		20	14	.....	.....
Apr. 30	188	559		4 12		20	15	.....	.....

Arsenal, at Sandy Hook, N. J., April 23 to 30, 1891.

gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Bow-spring brake on right wheel broken.....	
Spiral-spring brake clevis attachment used on right wheel.	
.....	
.....	Cannon friction primers, model 1887.
Clevis of brake on right wheel broken.....	Elevation, zero.
.....	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
.....	Fired into field butt.
.....	
Right brake jumped off wheel in recoiling.....	
Right brake jumped off wheel in recoiling.....	
Right brake jumped off wheel in recoiling.....	
Right brake jumped off wheel in recoiling.....	
Left side of recess in carrier ring showing signs of upsetting.	
.....	Since last firing a piece of steel 1⅝ inches long ⅝ inch wide, and $\frac{18}{32}$ inch thick was dovetailed into left side of recess in carrier ring.
.....	Fired into field butt.
.....	It was found that the metal used in dovetailing recess in carrier ring was too soft. A piece harder in substance was inserted after this firing.
.....	
.....	
.....	Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, of board for testing rifled cannon.
.....	
.....	
.....	
.....	
.....	

to left side of recess in carrier ring.]

.....	Gun mounted on Buffington steel field carriage, No. 4. Bow-spring brake on left wheel; old spiral-spring brake on right wheel.
.....	Elevation, zero.
.....	Fired into field butt.
.....	Cannon friction primers, model 1887.
.....	Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.

gun for endurance.]

.....	
.....	
.....	
.....	
.....	
.....	
.....	Gun mounted on Buffington steel field carriage, No. 4. Bow-spring brake on left wheel; old spiral-spring brake on right wheel.
.....	
.....	Elevation, zero.
.....	Cannon friction primers, model 1887.
.....	Fired into field butt.
.....	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
.....	
.....	
.....	
.....	
.....	
.....

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Including sand.	Instrumental velocity, —— feet from muzzle.	Pressure per square inch of bore.
			Kind.	Weight.	Kind.	Weight.			
P. M.				*Lbs. Oz.*		*Pounds.*	*Lbs. Oz.*	*Feet.*	*Pounds.*
Apr. 30	189	560	Laflin & Rand's L. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	15	.....	.....
Apr. 30	190	561		4 12		20	15	.....	.....
Apr. 30	191	562		4 12		20	13	.....	.....
Apr. 30	192	563		4 12		20	12	.....	.....
Apr. 30	193	564		4 12		20	15	.....	.....
Apr. 30	194	565		4 12		20	14	.....	.....
Apr. 30	195	566		4 12		20	12	.....	.....
Apr. 30	196	567		4 12		20	13	.....	.....
Apr. 30	197	568		4 12		20	12	.....	.....
Apr. 30	198	569		4 12		20	11	.....	.....
Apr. 30	199	570		4 12		20	1 0	.....	.....
Apr. 30	200	571		4 12		20	15	.....	.....
Apr. 30	201	572		4 12		20	14	.....	.....
Apr. 30	202	573		4 12		20	15	.....	.....
Apr. 30	203	574		4 12		20	15	.....	.....
Apr. 30	204	575		4 12		20	14	.....	No. 3, 35, 510
Apr. 30	205	576		4 12		20	13	.....	.....
Apr. 30	206	577		4 12		20	14	.....	.....
Apr. 30	207	578		4 12		20	15	.....	.....
Apr. 30	208	579		4 12		20	13	.....	.....
Apr. 30	209	580		4 12		20	12	.....	.....
Apr. 30	210	581	Laflin & Rand's L. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell rebanded.	20	14	.....	.....
Apr. 30	211	582		4 12		20	15	.....	.....
Apr. 30	212	583		4 12		20	13	.....	.....
Apr. 30	213	584		4 12		20	14	.....	.....
Apr. 30	214	585		4 12		20	12	.....	.....
Apr. 30	215	586		4 12		20	11	.....	.....
Apr. 30	216	587		4 12		20	14	.....	.....
Apr. 30	217	588		4 12		20	15	.....	.....
Apr. 30	218	589		4 12		20	14	.....	.....
Apr. 30	219	590		4 12		20	13	.....	.....
Apr. 30	220	591		4 12		20	15	.....	.....
Apr. 30	221	592		4 12		20	14	.....	.....
Apr. 30	222	593		4 12		20	1 0	.....	.....
Apr. 30	223	594		4 12		20	1 2	.....	.....
Apr. 30	224	595		4 12		20	15	.....	No. 3, 35, 800
Apr. 30	225	596		4 12		20	14	.....	.....
Apr. 30	226	597		4 12		20	12	.....	.....
Apr. 30	227	598		4 12		20	14	.....	.....
Apr. 30	228	599		4 12		20	15	.....	.....
Apr. 30	229	600		4 12		20	12	.....	.....
Apr. 30	230	601	Laflin & Rand's L. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Lot 249. Shell (banded), experimental, lot 249.	20	13	.....	.....
Apr. 30	231	602		4 12		20	15	.....	.....
Apr. 30	232	603		4 12		20	14	.....	.....
Apr. 30	233	604		4 12		20	14	.....	.....
Apr. 30	234	605		4 12		20	13	.....	.....
Apr. 30	235	606		4 12		20	13	.....	.....
Apr. 30	236	607	Laflin & Rand's L. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Lot 249. Shell (banded), experimental, lot 249.	20	14	.....	.....
Apr. 30	237	608		4 12		20	14	.....	.....
Apr. 30	238	609		4 12		20	14	.....	.....
Apr. 30	239	610		4 12		20	12	.....	.....
Apr. 30	240	611		4 12		20	13	.....	.....
Apr. 30	241	612		4 12		20	14	.....	.....
Apr. 30	242	613		4 12		20	15	.....	.....
Apr. 30	243	614		4 12		20	14	.....	.....
Apr. 30	244	615		4 12		20	15	.....	.....
Apr. 30	245	616		4 12		20	11	.....	.....
Apr. 30	246	617		4 12		20	12	.....	.....
Apr. 30	247	618		4 12		20	15	.....	.....
Apr. 30	248	619		4 12		20	15	.....	.....
Apr. 30	249	620		4 12		20	14	.....	.....
Apr. 30	250	621		4 12		20	14	.....	.....
Apr. 30	251	622		4 12		20	14	.....	.....
Apr. 30	252	623		4 12		20	15	.....	.....
Apr. 30	253	624		4 12		20	15	.....	.....
Apr. 30	254	625		4 12		20	14	.....	.....
Apr. 30	255	626		4 12		20	12	.....	.....

Watervliet Arsenal, at Sandy Hook, N. J., April 30, 1891.

gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
First cartridge was too large to enter chamber ..	
First primer failed to ignite charge	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on left wheel; old spiral-spring brake on right wheel.
	Elevation, zero.
	Cannon friction primers, model 1887.
Left brake jumped off wheel in recoiling	Fired into field butt.
	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
First cartridge was too large to enter chamber ..	
Two bolts attaching fork of elevating gear to cheeks of carriage broken. Middle of right bolt found to be defective.	
First primer failed to ignite charge	
First primer failed to ignite charge	
It was noticed that the upper joint between the plates of the right flask had opened slightly near and in front of the support for the elevating screw.	Cannon friction primers, model 1887. Fired into field butt. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Crack in right seat of carriage continues to develop.
Right brake jumped off wheel in recoiling	Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, board for testing rifled cannon.
Crack starting in right angle of cannoneers' seat of carriage, right side.	

Record of firing with 3.6-inch B. L. rifle (steel), No 1, Watervliet

[Object of firing, to test

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Including sand.	Instrumental velocity, —— feet from muzzle.	Pressure per square inch of bore.
			Kind.	Weight.	Kind.	Weight.			
P. M.				*Lbs. Oz.*		*Pounds.*	*Lbs. Oz.*	*Feet.*	*Pounds.*
Apr. 30	256	627	Laflin & Rand's I. K., lot 1; density, 1.725; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	13	.....	.....
Apr. 30	257	628		4 12		20	14	.....	.....
Apr. 30	258	629		4 12		20	15	.....	.....
Apr. 30	259	630		4 12		20	12	.....	.....
Apr. 30	260	631		4 12		20	13	.....	.....
Apr. 30	261	632		4 12		20	12	.....	.....
Apr. 30	262	633		4 12		20	14	.....	.....
Apr. 30	263	634		4 12		20	15	.....	.....
Apr. 30	264	635		4 12		20	12	.....	.....
May 5	265	636		4 12		20	13	.....	.....
May 5	266	637		4 12		20	13	.....	.....
May 5	267	638		4 12		20	13	.....	.....
May 5	268	639		4 12		20	13	.....	.....
May 5	269	640		4 12		20	14	.....	.....
May 5	270	641		4 12		20	15	.....	.....
May 5	271	642		4 12		20	14	.....	.....
May 5	272	643		4 12		20	13	.....	.....
May 5	273	644		4 12		20	14	.....	.....
May 5	274	645		4 12		20	15	.....	.....
May 5	275	646		4 12		20	1 0	.....	.....
May 5	276	647		4 12		20	12	.....	.....
May 5	277	648		4 12		20	11	.....	.....
May 5	278	649		4 12		20	15	.....	.....
May 5	279	650		4 12		20	14	.....	.....
May 5	280	651		4 12		20	14	.....	.....
May 5	281	652		4 12		20	15	.....	.....
May 5	282	653		4 12		20	1 1	.....	.....
May 5	283	654		4 12		20	15	.....	.....
May 5	284	655		4 12		20	14	.....	.....
May 5	285	656		4 12		20	13	.....	.....
May 5	286	657		4 12		20	15	.....	.....
May 5	287	658		4 12		20	15	.....	.....
May 5	288	659		4 12		20	14	.....	.....
May 5	289	660		4 12		20	12	.....	.....
May 5	290	661		4 12		20	9	.....	.....
May 5	291	662		4 12		20	11	.....	.....
May 5	292	663		4 12		20	13	.....	.....
May 5	293	664		4 12		20	14	.....	.....
May 5	294	665		4 12		20	15	.....	.....
May 5	295	666		4 12		20	15	.....	.....
May 5	296	667		4 12		20	14	.....	.....
May 5	297	668		4 12		20	15	.....	.....
May 5	298	669		4 12		20	14	.....	.....
May 5	299	670		4 12		20	15	.....	.....
May 5	300	671		4 12		20	14	.....	.....
May 5	301	672		4 12		20	15	.....	.....
May 5	302	673		4 12		20	14	.....	.....
May 5	303	674		4 12		20	15	.....	.....
May 5	304	675		4 12		20	14	.....	.....
May 5	305	676		4 12		20	13	.....	.....
May 5	306	677		4 12		20	14	.....	.....
May 5	307	678		4 12		20	13	.....	.....
May 5	308	679		4 12		20	12	.....	.....
May 5	309	680		4 12		20	11	.....	.....
May 5	310	681		4 12		20	14	.....	.....
May 5	311	682		4 12		20	15	.....	.....
May 5	312	683		4 12		20	14	.....	.....
May 5	313	684		4 12		20	15	.....	.....
May 5	314	685		4 12		20	12	.....	No. 3, 34, 360
May 5	315	686		4 12		20	13	.....	.....
May 5	316	687		4 12		20	15	.....	.....
May 5	317	688		4 12		20	12	.....	.....
May 5	318	689		4 12		20	15	.....	.....
May 5	319	690		4 12		20	14	.....	.....
May 5	320	691		4 12		20	12	.....	.....
May 5	321	692		4 12		20	13	.....	.....
May 5	322	693		4 12		20	15	.....	.....
May 5	323	694		4 12		20	1 0	.....	.....
May 5	324	695		4 12		20	1 0	.....	.....
May 5	325	696		4 12		20	14	.....	.....
May 5	326	697		4 12		20	15	.....	.....
May 5	327	698		4 12		20	15	.....	.....
May 5	328	699		4 12		20	15	.....	.....
May 5	329	700	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12		20	14	.....	.....

Arsenal, at Sandy Hook, N. J., April 30 and May 5, 1891.

gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	Cannon friction primers, model 1887.
	Fired into field butt.
	Crack in right seat of carriage continues to develop.
Head of service rammer split	
	Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, of board for testing rifled cannon.
	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on left wheel; old spiral-spring brake on right wheel.
	Elevation, zero.
	Cannon friction primers, model 1887.
	Fired into sand butt.
	Before this firing opening between sleeve and ring was found to measure 0.018 of an inch.
First primer failed to ignite charge	
	Cannon friction primers, model 1887.
	Fired into field butt.
	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
Right brake jumped off wheel in recoiling	
Right brake jumped off wheel in recoiling	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Including sand.	Instrumental velocity, —— feet from muzzle.	Pressure per square inch of bore.
			Kind.	Weight.	Kind.	Weight.			
P. M.				*Lbs. Oz.*		*Pounds.*	*Lbs. Oz.*	*Feet.*	*Pounds.*
May 5	330	701	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	12	.....	.....
May 5	331	702		4 12		20	11	.....	.....
May 5	332	703		4 12		20	13	.....	.....
May 5	333	704		4 12		20	12	.....	.....
May 5	334	705		4 12		20	13	.....	.....
May 5	335	706		4 12		20	14	.....	.....
May 5	336	707		4 12		20	15	.....	.....
May 5	337	708		4 12		20	15	.....	.....
May 5	338	709		4 12		20	13	.....	.....
May 5	339	710		4 12		20	12	.....	.....
May 5	340	711		4 12		20	11	.....	.....
May 5	341	712		4 12		20	12	.....	.....
May 5	342	713		4 12		20	14	.....	.....
May 5	343	714		4 12		20	15	.....	.....
May 5	344	715		4 12		20	13	.....	.....
May 5	345	716		4 12		20	14	.....	.....
May 5	346	717		4 12		20	15	.....	.....
May 5	347	718		4 12		20	13	.....	.....
May 5	348	719		4 12		20	14	.....	.....
May 5	349	720		4 12		20	14	.....	.....
May 5	350	721		4 12		20	12	.....	.....
May 5	351	722		4 12		20	11	.....	.....
May 5	352	723		4 12		20	12	.....	.....
May 5	353	724		4 12		20	13	.....	.....
May 5	354	725		4 12		20	15	.....	.....
May 5	355	726		4 12		20	14	.....	.....
May 5	356	727		4 12		20	15	.....	.....
May 5	357	728		4 12		20	13	.....	.....
May 5	358	729		4 12		20	12	.....	.....
May 5	359	730		4 12		20	11	.....	.....
May 5	360	731		4 12		20	14	.....	.....
May 5	361	732		4 12		20	14	.....	.....
May 5	362	733		4 12		20	14	.....	.....
May 5	363	734		4 12		20	14	.....	.....
May 5	364	735		4 12		20	14	.....	No. 3, 37, 720
May 5	365	736		4 12		20	14	.....	.....
May 5	366	737		4 12		20	15	.....	.....
May 5	367	738		4 12		20	13	.....	.....
May 5	368	739		4 12		20	12	.....	.....
May 5	369	740		4 12		20	13	.....	.....
May 5	370	741		4 12		20	15	.....	.....
May 5	371	742		4 12		20	15	.....	.....
May 5	372	743		4 12		20	13	.....	.....
May 5	373	744		4 12		20	12	.....	.....
May 5	374	745		4 12		20	11	.....	.....
May 5	375	746		4 12		20	14	.....	.....
May 5	376	747		4 12		20	14	.....	.....
May 5	377	748		4 12		20	15	.....	.....
May 5	378	749		4 12		20	15	.....	.....
May 5	379	750		4 12		20	14	.....	.....
May 5	380	751		4 12		20	13	.....	.....
May 5	381	752		4 12		20	12	.....	.....
May 5	382	753		4 12		20	11	.....	.....
May 5	383	754		4 12		20	14	.....	.....
May 5	384	755		4 12		20	13	.....	.....
May 5	385	756		4 12		20	14	.....	.....
May 5	386	757		4 12		20	14	.....	.....
May 5	387	758		4 12		20	12	.....	.....
May 5	388	759		4 12		20	15	.....	.....
May 5	389	760		4 12		20	14	.....	.....
May 5	390	761		4 12		20	13	.....	.....
May 5	391	762		4 12		20	15	.....	.....
May 5	392	763		4 12		20	14	.....	.....
May 5	393	764		4 12		20	15	.....	.....
May 5	394	765		4 12		20	15	.....	.....
May 5	395	766		4 12		20	13	.....	.....
May 5	396	767		4 12		20	12	.....	.....
May 5	397	768		4 12		20	11	.....	.....
May 5	398	769		4 12		20	11	.....	.....
May 5	399	770		4 12		20	1 0	.....	.....
May 5	400	771		4 12		20	1 0	.....	.....
May 5	401	772		4 12		20	15	.....	.....
May 5	402	773		4 12		20	14	.....	.....
May 5	403	774		4 12		20	13	.....	.....

Watervliet Arsenal, at Sandy Hook, N. J., May 5, 1891.

gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Primer failed to ignite charge	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on left wheel; old spiral-spring brake on right wheel. Cannon friction primers, model 1887. Fired into field butt. Copper cylinders of 32,000 pounds initial compression and tables of 1890.
	Cannon friction primers, model 1887. Right-hand clamp for holding sponge in place became bent during firing, having been left unlatched. Fired into sand butt. Copper cylinders of 32,000 pounds initial compression and tables of 1890.
	Cannon friction primers, model 1887. Fired into field butt. After this firing it was found that the following bolts and nuts had become loosened: Right upper bolt through right side of middle transom; rear tap bolt connecting axle plate to flask; first and second tap bolts connecting left flask to axle plate. Firing conducted by the testing board. Present: Maj. G. W. McKee, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, of board for testing rifled cannon.
Nuts on bolts in elevating gear tightened	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Including sand.	Instrumental velocity, —— feet from muzzle.	Pressure per square inch of bore.
			Kind.	Weight.	Kind.	Weight.			
P. M.				*Lbs. Oz.*		*Pounds.*	*Lbs. Oz.*	*Feet.*	*Pounds.*
May 5	404	775	Laflin & Rand's L. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	12	.....	.....
May 5	405	776		4 12		20	13	.....	.....
May 5	406	777		4 12		20	14	.....	.....
May 5	407	778		4 12		20	13	.....	.....
May 5	408	779		4 12		20	15	.....	.....
May 5	409	780		4 12		20	14	.....	.....
May 5	410	781		4 12		20	12	.....	.....
May 5	411	782		4 12		20	13	.....	.....
May 5	412	783		4 12		20	15	.....	.....
May 5	413	784		4 12		20	14	.....	.....
May 5	414	785		4 12		20	14	.....	.....
A. M.									
May 6	415	786		4 12		20	14	.....	.....
May 6	416	787		4 12		20	13	.....	.....
May 6	417	788		4 12		20	14	.....	.....
May 6	418	789		4 12		20	15	.....	.....
May 6	419	790		4 12		20	13	.....	.....
May 6	420	791		4 12		20	14	.....	.....
May 6	421	792		4 12		20	12	.....	.....
May 6	422	793		4 12		20	14	.....	.....
May 6	423	794		4 12		20	13	.....	.....
May 6	424	795		4 12		20	15	.....	.....
May 6	425	796		4 12		20	14	.....	.....
May 6	426	797		4 12		20	13	.....	.....
May 6	427	798		4 12		20	12	.....	.....
May 6	428	799		4 12		20	14	.....	.....
May 6	429	800		4 12		20	1 0	.....	.....
May 6	430	801		4 12		20	1 0	.....	.....
May 6	431	802		4 12		20	15	.....	.....
May 6	432	803		4 12		20	14	.....	.....
May 6	433	804		4 12		20	13	.....	.....
May 6	434	805		4 12		20	15	.....	.....
May 6	435	806		4 12		20	14	.....	.....
May 6	436	807		4 12		20	12	.....	.....
May 6	437	808		4 12		20	14	.....	.....
May 6	438	809		4 12		20	13	.....	.....
May 6	439	810		4 12		20	15	.....	.....
May 6	440	811		4 12		20	15	.....	.....
May 6	441	812		4 12		20	15	.....	.....
May 6	442	813		4 12		20	14	.....	.....
May 6	443	814		4 12		20	12	.....	.....
May 6	444	815		4 12		20	14	.....	.....
May 6	445	816		4 12		20	13	.....	.....
May 6	446	817		4 12		20	11	.....	.....
May 6	447	818		4 12		20	10	.....	.....
May 6	448	819		4 12		20	14	.....	.....
May 6	449	820		4 12		20	14	.....	.....
May 6	450	821		4 12		20	15	.....	.....
May 6	451	822		4 12		20	14	.....	.....
May 6	452	823		4 12		20	15	.....	.....
May 6	453	824		4 12		20	14	.....	.....
May 6	454	825		4 12		20	13	.....	.....
May 6	455	826		4 12		20	14	.....	.....
May 6	456	827		4 12		20	15	.....	.....
May 6	457	828		4 12		20	14	.....	.....
May 6	458	829		4 12		20	13	.....	.....
May 6	459	830		4 12		20	15	.....	.....
May 6	460	831		4 12		20	14	.....	.....
May 6	461	832		4 12		20	1 6	.....	.....
May 6	462	833		4 12		20	1 6	.....	.....
May 6	463	834		4 12		20	1 4	.....	.....
May 6	464	835		4 12		20	1 3	.....	No. 3, 34, 140
May 6	465	836		4 12		20	1 2	.....	No. 3, 33, 800

Arsenal, at Sandy Hook, N. J., May 5 and 6, 1891.

gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	Cannon friction primers, model 1887. Fired into field butt. After this firing it was found that the following bolts and nuts had become loosened: Right upper bolt through right side of middle transom; rear tap bolt connecting axle plate to flask; first and second tap bolts connecting left flask to axle plate. Firing conducted by the testing board. Present: Maj. G. W. McKee, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, of board for testing rifled cannon.
Difficulty to withdraw breechblock, due to sticking of gas check in seat.	
One additional washer placed in rear of spring on spindle of mushroom head.	
First cartridge was too large to enter chamber...	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on left wheel; old spiral-spring brake on right wheel. Elevation, zero. Cannon friction primers, model 1887. All loose bolts and nuts on carriage tightened before this firing. Fired into field butt. Two copper washers were slipped over spindle of mushroom head before this firing. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by the testing board. Present: Maj. G. W. McKee, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, of board for testing rifled cannon.
First cartridge was too large to enter chamber...	
Bow-spring brake on left wheel broken..... Old spiral-spring brake attached	
Right brake jumped off wheel in recoiling.....	
Cartridge ignited 6 inches from rear..... Cartridge ignited 6½ inches from rear.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to

Date.	No. of fire.	Powder.		Projectile.		Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.	Kind.	Weight.			
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*	*Feet.*
May 11	837	Laflin & Rand's I. K., lot 1.	4 12	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	.....	.....	15
May 11	838	Du Pont's V. A., lot 1; density, 1.750; granulation, 2,780. Received May 7, 1891.	4 8		19 3 13 sand. 20 0	1,504 1,496	No. 3, 33, 950	14
May 11	839		4 8		19 2 14 sand. 20 0	1,499 1,492	No. 3, 32, 400	13
May 11	840		4 12		19 0 1 0 sand. 20 0	1,542 1,538	No. 3, 39, 850	14
May 11	841		4 12		19 2 14 sand. 20 0	1,531 1,529 50+$\frac{15}{2}$°	No. 3, 38, 160	14
May 18	842	Laflin & Rand's I. K., lot 1.	4 12		19 2 14 sand. 20 0	.....	.....	15
May 18	843	Du Pont's V. A., lot 2; density, 1.750; granulation, 2,830. Received May 15, 1891.	4 8		19 2 11 sand. 20 0	1,484 1,480	No. 3, 36, 000	14
May 18	844		4 8		19 5 11 sand. 20 0	1,476 1,476	No. 3, 38, 200	19
May 18	845		4 8		19 5 11 sand. 20 0	1,488 1,487	No. 3, 47, 400	15
May 18	846		4 0		19 3 13 sand. 20 0	1,382 1,381	No. 3, less than 32, 000	14
May 18	847		4 4		19 4 12 sand. 20 0	1,424 1,421	No. 3, 32, 000	15
May 18	848		4 8		19 2 14 sand. 20 0	1,486 1,486 50+$\frac{15}{2}$°	No. 3, 48, 700	15

Watervliet Arsenal, at Sandy Hook, N. J., May 11 and 18, 1891.

prove powder.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Warming charge; fired to sea.....	
First primer failed to ignite charge.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt. Vent reamed out before this firing. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
.....,.....	
.....,.....	
.....	
Warming charge.....	
.....	
Left brake jumped off wheel in recoiling.....	Gun mounted on Buffington steel field carriage No. 4. Spiral-spring brake; clevis attachment on right wheel; old spiral-spring brake on left wheel. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1890. In rounds 843 to 848, inclusive, the mushroom head was in contact with cartridge bag.
.....	
.....	
.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.	Kind.	Weight.			
P. M. May 18	849	Laflin & Rand's I. K., lot 1.	*Lbs. Oz.* 4 12	Shell (banded), experimental, lot 249.	*Lbs. Oz.* 19 2 14 sand. 20 0	*Feet.*	.....	*Feet.* 15
May 18	850	Du Pont's V. A., lot 4; density, 1.750; granulation, 2,288. Received May 15, 1891.	4 4		19 4 12 sand. 20 0	1,432 1,434	No. 3, 32,860	15
May 18	851		4 6		19 1 15 sand. 20 0	1,477 1,467	No. 3, 43,700	14
May 18	852		4 6		19 0 1 0 sand. 20 0	1,453 1,451	No. 3, 32,150	15
May 18	853		4 8		19 2 14 sand. 20 0	Lost. 1,469	No. 3, 32,700	15
May 18	854		4 12		19 2 14 sand. 20 0	1,519 1,514	No. 3, 39,080	16
May 18	855		4 12		19 1 15 sand. 20 0	1,524 1,522	No. 3, 35,860	16
May 18	856		4 12		19 3 13 sand. 20 0	1,532 1,522	No. 3, 38,680	16
						50+$\frac{150}{2}$		

Watervliet Arsenal, at Sandy Hook, N. J., May 18, 1891.

to prove powder.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Warming charge.....	
.....	
.....	
Cartridge pushed up against projectile	Gun mounted on Buffington steel field carriage No. 4. Spiral-spring brake; clevis attachment on right wheel; old spiral-spring brake on left wheel. Cannon friction primers, model 1887. In rounds 850 and 851 the mushroom head was in contact with cartridge bag.
Cartridge pushed up against projectile	Fired into sand butt. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Gun-star gauged after round 856, May 20, by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
.....	
.....	
.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to

	No. of series.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Wind allowance (divisions right).	Recoil.
				Lbs. Oz.		*Lbs. Oz.*	° ′		*Feet.*
P M.....	466	857	Laflin & Rand's I. K., lot 1; density, 1.725; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	5 10	.....	12
	467	858		4 12		19 2 14 sand. 20 0	5 16	.....	14
	468	859		4 12		19 2 14 sand. 20 0	5 16	.....	14
	469	860		4 12		19 3 13 sand. 20 0	5 16	.....	14
	470	861		4 12		19 2 14 sand. 20 0	5 16	.....	15
	471	862		4 12		19 2 14 sand. 20 0	5 16	.....	14
	472	863		4 12		19 1 15 sand. 20 0	5 16	.....	14
	473	864		4 12		19 2 14 sand. 20 0	5 14	2	15
	474	865		4 12		19 1 15 sand. 20 0	5 14	2	15
	475	866		4 12		19 2 14 sand. 20 0	5 10	2	14
	476	867		4 12		19 1 15 sand. 20 0	5 10	2	15

Watervliet Arsenal, at Sandy Hook, N. J., May 20, 1891.

test gun for accuracy.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
From right, 10 miles an hour.	Sighting shot. Struck 500 feet in front of target.	Gun mounted on Buffington steel field carriage No. 4. Spiral-spring brake-clevis attachment on right wheel; old spiral-spring brake on left wheel. Cannon friction primers, model 1887. Fired at 3,000-yards target. Aimed at left upper corner of target. Scott's sight used on right trunnion.
	Sighting shot. Struck target 10½ feet below and 4 feet left of center.	
	Sighting shot. Struck target 10 feet below and 2¼ feet right of center.	
	Sighting shot. Struck target 9¾ feet above center.	
	Sighting shot. Struck target 6 feet above and 4¾ feet left of center.	
	Sighting shot. Miss	
	Sighting shot. Struck about 300 feet beyond target.	
	Sighting shot. Struck target 10 feet above and 13 feet right of center.	
	Sighting shot. Struck about 300 feet beyond target.	
	Sighting shot. Struck target 4½ feet below and 15¼ feet right of center.	
	Sighting shot. Miss	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to

	No. of series.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Wind allowance (divisions right).	Recoil.	Wind, strength and direction.
				Lbs. Oz.		*Lbs. Oz.*	° ′			*Feet.*
P. M...	477	868	Laflin and Rand's I. K., lot 1; density, 1.725; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	5 10	¾	14	From right, 10 miles an hour.
	478	869		4 12		19 3 13 sand. 20 0	5 10	¾	20	
	479	870		4 12		19 3 13 sand. 20 0	5 10	¾	15	
	480	871		4 12		19 2 14 sand. 20 0	5 10	¾	25	
	481	872		4 12		19 1 15 sand. 20 0	5 10	¾	14	
	482	873		4 12		19 2 14 sand. 20 0	5 10	¾	15	
	483	874		4 12		19 1 15 sand. 20 0	5 10	¾	24	
	484	875		4 12		19 4 12 sand. 20 0	5 10	¾	15	
	485	876		4 12		19 2 14 sand. 20 0	5 10	¾	14	
	486	877		4 12		19 4 12 sand. 20 0	5 10	¾	14	

Watervliet Arsenal, at Sandy Hook, N. J., May 20, 1891—Continued.

test gun for accuracy.]

From center of target.				From center of impact.				Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Vertical		Horizontal.		Vertical.		Horizontal.			
Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.		
Ft.	*Ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*		
2	....	.25	.....	3.156	.....	.....	.28	.....	
....	9¼	0.50	.....	.....	8.094	9.032	.....	.....	Fired at 3,000-yards target. Aimed at left upper corner of target. Cannon friction primers, model 1887. Scott's sight used on right trunnion.
....	14½	.....	1.00	.....	13.344	.....	1.468	.....	
3¼	....	.25	.....	4.406	.....	.....	.218	.....	
4½	....	3.75	.....	5.656	.....	3.282	.....	.....	
....	11¼	.....	.25	.....	10.094	.....	.718	First primer failed to ignite cartridge. Head of primer blown off; base intact.	
10	....	.....	3.25	11.156	.....	.....	3.718	.....	
6	....	.....	5.50	7.156	.....	.....	5.968	.....	
....	....	.....	.....	.....	.....	.....	.....	Miss. Struck in front of target.	
....	10½	.....	1.75	.....	.....	.....	.....	.....	

Feet.

Center of impact:
- Below 1.156
- Right 0.468

Mean vertical deviation from center of impact.... 7.882

Mean horizontal deviation from center of impact 3.077

Mean deviation from center of impact 8.461

Deviation of center of impact from plane of fire, right 14.843

Gun sighted by Lieut. W. W. Gibson, Ordnance Department.

Target observed by Lieut. C. B. Wheeler, Ordnance Department.

Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, of board for testing rifled cannon.

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to

Date.	No. of series.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Including sand.
A. M.				*Lbs. Oz.*		*Pounds.*	*Ounces.*
May 21	487	878	Laflin & Rand's L. K., lot 1; density, 1.750; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	13
May 21	488	879		4 12		20	14
May 21	489	880		4 12		20	14
May 21	490	881		4 12		20	15
May 21	491	882		4 12		20	12
May 21	492	883		4 12		20	11
May 21	493	884		4 12		20	15
May 21	494	885		4 12		20	11
May 21	495	886		4 12		20	15
May 21	496	887		4 12		20	14
May 21	497	888		4 12		20	14
May 21	498	889		4 12		20	14
May 21	499	890		4 12		20	13
May 21	500	891		4 12		20	12
May 21	501	892		4 12		20	14
May 21	502	893		4 12		20	13
May 21	503	894		4 12		20	12
May 21	504	895		4 12		20	14
May 21	505	896		4 12		20	15
May 21	506	897		4 12		20	13
May 21	507	898		4 12		20	13
May 21	508	899		4 12		20	13
May 21	509	900		4 12		20	14
May 21	510	901		4 12		20	13
May 21	511	902		4 12		20	14
May 21	512	903		4 12		20	13
May 21	513	904		4 12		20	14
P. M.							
May 21	514	905		4 12		20	15
May 21	515	906		4 12		20	14
May 21	516	907		4 12		20	12
May 21	517	908		4 12		20	14
May 21	518	909		4 12		20	15
May 21	519	910		4 12		20	15
May 21	520	911		4 12		20	11
May 21	521	912		4 12		20	12
May 21	522	913		4 12		20	13
May 21	523	914		4 12		20	15
May 21	524	915		4 12		20	14
May 21	525	916		4 12		20	15
May 21	526	917		4 12		20	14

[Object of firing, to test gun

May 21	527	918	Laflin & Rand's L. K., lot 1; density, 1.750; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	14
May 21	528	919		4 12		20	13
May 21	529	920		4 12		20	12
May 21	530	921		4 12		20	14
May 21	531	922		4 12		20	15
May 21	532	923		4 12		20	15
May 21	533	924		4 12		20	14
May 21	534	925		4 12		20	13
May 21	535	926		4 12		20	12
May 21	536	927		4 12		20	11
May 21	537	928		4 12		20	13
May 21	538	929		4 12		20	12
May 21	539	930		4 12		20	14
May 21	540	931		4 12		20	15
May 21	541	932		4 12		20	12
May 21	542	933		4 12		20	15
May 21	543	934		4 12		20	14
May 21	544	935		4 12		20	14
May 21	545	936		4 12		20	14
May 21	546	937		4 12		20	13
May 21	547	938		4 12		20	15
May 21	548	939		4 12		20	15
May 21	549	940		4 12		20	15
May 21	550	941		4 12		20	14
May 21	551	942		4 12		20	12
May 21	552	943		4 12		20	13
May 21	553	944		4 12		20	15
May 21	554	945		4 12		20	14

Watervliet Arsenal, at Sandy Hook, N. J., May 21, 1891.

test gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
.....	
.....	
.....	
.....	
.....	
.....	
Nuts in journal box of elevating gear tightened.	
.....	
.....	
.....	
.....	
.....	
.....	
.....	
First cartridge was too large to enter chamber ..	
.....	Gun mounted on Buffington steel field carriage lot 4. Old spiral-spring brakes.
.....	Elevation, zero.
.....	Cannon friction primers, model 1887.
.....	Fired into field butt.
.....	
Sleeve of old spiral-spring brake split open.....	All loose bolts and nuts in carriage tightened before this firing.
.....	
.....	Before round 910 a spiral-spring brake reported broken in round No. 508, and, having been repaired, was attached to left wheel of carriage.
.....	
.....	
.....	
.....	
.....	
Rear gas-check cup filed off.....	
.....	
.....	
.....	
.....	
.....	
.....	
.....	
.....	
.....	
.....	

for endurance and rapidity.]

.....	
.....	
.....	
.....	
.....	
.....	
Gun hung fire.....	
.....	
Right brake jumped off wheel in recoiling	
.....	
.....	Cannon friction primers, model 1887.
Right brake jumped off wheel in recoiling	Time occupied in firing 20 rounds (from 916 to 935), 13 minutes.
.....	Fired into field butt.
.....	
.....	
.....	
.....	
Front key in right cap square broken	
.....	
Right brake jumped off wheel in recoiling.....	
.....	
.....	
.....	
.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to

Date.	No of series.	No. of fire.	Powder.		Projectile.		Including sand.
			Kind.	Weight.	Kind.	Weight.	
P. M.				*Lbs. Oz.*		*Pounds.*	*Ounces.*
May 21	555	946	Laflin & Rand's I. K., lot 1; density, 1.750; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	15
May 21	556	947		4 12		20	15
May 21	557	948		4 12		20	15
May 21	558	949		4 12		20	13
May 21	559	950		4 12		20	12
May 21	560	951		4 12		20	14
May 21	561	952		4 12		20	13
May 21	562	953		4 12		20	12
May 21	563	954		4 12		20	14
May 21	564	955		4 12		20	15
May 21	565	956		4 12		20	14
May 21	566	957		4 12		20	15
May 21	567	958		4 12		20	14
May 21	568	959		4 12		20	12
May 21	569	960		4 12		20	13
May 21	570	961		4 12		20	14
May 21	571	962		4 12		20	12
May 21	572	963		4 12		20	14
May 21	573	964		4 12		20	15
May 21	574	965		4 12		20	14
May 21	575	966		4 12		20	15
May 21	576	967		4 12		20	14
May 21	577	968		4 12		20	13
May 21	578	969		4 12		20	12
May 21	579	970		4 12		20	14
May 21	580	971		4 12		20	15
May 21	581	972		4 12		20	14
May 21	582	973		4 12		20	15
May 21	583	974		4 12		20	15
May 21	584	975		4 12		20	14
May 21	585	976		4 12		20	15
May 21	586	977		4 12		20	15
May 21	587	978		4 12		20	14
May 21	588	979		4 12		20	12
May 21	589	980		4 12		20	12
A. M.							
May 25	590	981	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12		20	14
May 25	591	982		4 12		20	14
May 25	592	983		4 12		20	14
May 25	593	984		4 12		20	14
May 25	594	985		4 12		20	13
May 25	595	986		4 12		20	13
May 25	596	987		4 12		20	14
May 25	597	988		4 12		20	13
May 25	598	989		4 12		20	15

Arsenal, at Sandy Hook, N. J., May 21 and 25, 1891.

test gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
.....	
.....	
.....	
.....	
Cartridge was too large to enter chamber.....	
.....	
.....	
.....	
.....	
.....	
.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral spring brakes.
.....	Cannon friction primers, model 1887.
.....	Fired into field butt.
Right brake jumped off wheel in recoiling.....	Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, of board for testing rifled cannon.
.....	
.....	
Right brake jumped off wheel	
.....	
.....	
First cartridge was too large to enter chamber..	
.....	
.....	
.....	
First primer failed to ignite charge.....	
.....	
.....	
.....	
.....	
.....	
.....	
.....	
.....	
Bolt in clevis of right brake broken.....	
	Gun mounted on Buffington steel field carriage No. 4. Old spiral spring brake on right wheel; spiral spring brake, clevis attachment, on left wheel.
Right brake jumped off wheel in recoiling.....	Elevation, zero.
Right brake jumped off wheel in recoiling.....	Cannon friction primers, model 1887.
.....	Fired into field butt.
.....	Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, of board for testing rifled cannon.
Right brake jumped off wheel in recoiling.....	
Right brake jumped off wheel in recoiling.....	
Right brake jumped off wheel in recoiling.....	
.....	
Two bolts, attaching fork of elevating screw to cheeks of carriage broken.	

Record of firing with 3.6-inch B. L. rifle (steel) No. 1,

[Object of firing,

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
			Lbs. Oz.		*Lbs. Oz.*	*Feet.*	*Pounds.*	*Feet.*
P. M ..	990	Laflin & Rand's I. K., lot 1.	4 12	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	.....	.....	14
	991	Du Pont's sphero-hexagonal V. E.; density, 1.770; granulation, 114.	4 4		19 3 13 sand. 20 0	1,431 Lost.	No. 3, 28,000	15
	992		4 8		19 2 14 sand. 20 0	1,467 1,443	No. 3, 28,200	15
	993		4 4		19 3 13 sand. 20 0	1,483 Lost.	No. 3, 31,000	15
	994		4 8		19 2 14 sand. 20 0	1,531 1,531	No. 3, 34,840	18
	995		4 8		19 1 15 sand. 20 0	1,533 1,531	No. 3, 34,840	17
	996		4 8		19 5 11 sand. 20 0	1,544 1,546 50 + 159/2	No. 3, 35,900	17

Record of firing with 3.6-inch B. L. rifle (steel) No. 1,

[Object of firing, to test Merriam base

	No. of series.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Fuse marked.	Elevation.
				Lbs. Oz.		*Lbs. Oz.*		° ′
P. M	2	997	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell, lot 249, altered to receive Merriam base percussion fuse.	19 4 fuse and shell. 3 rifle powder, bursting charge. 19 7	No. 58...	05
	3	998		4 12		19 7 fuse and shell. 3 rifle powder, bursting charge. 19 10	No. 60...	2 00
	4	999		4 12		19 8 shell and fuse.	No. 59...	05

Watervliet Arsenal, at Sandy Hook, N. J., May 26, 1891.

to prove powder.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Warming charge	Gun mounted on Buffington steel field carriage No. 4. Old spiral spring brake on right wheel; spiral-spring brake, clevis attachment, on left wheel. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt. Copper cylinders of 28,000 pounds initial compression and tables of 1890 used in rounds 991 to 993, inclusive. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 994 to 996, inclusive. Firing conducted by Lieut. W. W. Gibson Ordnance Department, assistant proof officer.
.....	
Cartridge inserted with slight difficulty, due to cartridge bag being too large in diameter.	
.....	
Right brake jumped off wheel in recoiling.....	
Right brake jumped off wheel in recoiling.....	
Right brake jumped off wheel in recoiling.....	

Watervliet Arsenal, at Sandy Hook, N. J., June 2, 1891.

percussion fuse (automatic).]

Pressure per square inch of bore.	Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*		
No. 3, 37, 360	16	Fuse had an extra heavy head; shell burst on striking butt.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; spiral-spring brake, clevis attachment, on left wheel. Rounds 997 and 999 fired into field butt. Copper cylinders of 32,000 pounds initial compression and tables of 1887. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
No. 3, 39, 950	16	Fuse had a medium weight head; fired to sea; ricocheted once; did not burst.	
No. 3, 36, 970	17	Fuse had a light weight head	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test gun for

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Elevation.	Recoil.	Wind, strength and direction.
			Kind.	Weight.	Kind.	Weight.			
P. M.				*Lbs. Oz.*		*Lbs. Oz.*	°	*Feet.*	
June 8	599	1000	Laflin & Rand's I. K., lot 1; density, 1.716; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 3 3 sand. 20 0	2	16	From right and front, 5 miles an hour.
June 8	600	1001		4 12		19 4 12 sand. 20 0	2	14	
June 8	601	1002		4 12		19 3 13 sand. 20 0	2	13	
June 8	602	1003		4 12		19 2 14 sand. 20 0	2	14	
June 8	603	1004		4 12		19 4 12 sand. 20 0	2	14	
June 8	604	1005		4 12		19 3 13 sand. 20 0	2	14	
June 8	605	1006		4 12		19 2 14 sand. 20 0	2	15	
June 8	606	1007		4 12		19 2 14 sand. 20 0	2	14	
June 8	607	1008		4 12		19 2 14 sand. 20 0	2	14	
June 8	608	1009		4 12		10 3 13 sand. 20 0	2	14	
June 8	609	1010		4 12		19 2 14 sand. 20 0	2	14	
June 8	610	1011		4 12		19 1 15 sand. 20 0	4	13	
June 8	611	1012		4 12		19 3 13 sand. 20 0	4	14	
June 8	612	1013		4 12		19 2 14 sand. 20 0	4	15	
June 8	613	1014		4 12		19 2 14 sand. 20 0	4	14	

Watervliet Arsenal, at Sandy Hook, N. J., June 8, 1891.

endurance and range firing.]

Range.	Deflection.		Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	Right.	Left.		
Yards.	*Yards.*	*Yards.*		
.....	.....	.....	First cartridge too large to enter chamber. Right brake came off wheel in recoiling. Angles lost.	
1,652	.....	6	.....	
1,661	.....	7	First primer failed; head blown off, base intact.	
1,632	.....	11	Right brake came off wheel in recoiling.	
1,616	.....	10	.....	
1,642	.....	3	.....	
1,683	.....	14	.....	
1,653	.....	6	Gun hung fire	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; spiral-spring brake, clevis attachment, on left wheel. Fired to sea. Cannon friction primers, model 1878.
1,653	.....	4	.....	
1,650	.....	4	Boiler iron that separates bar which connects radius bar with the cheeks of carriage is split along the joint.	
1,621	.....	2	.....	
2,567	.....	18	.....	
2,551	.....	6	.....	
2,586	.....	11	.....	
2,584	.....	11	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test gun for

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Elevation.	Recoil.	Wind, strength and direction.
			Kind.	Weight.	Kind.	Weight.			
P. M.				*Lbs. Oz.*		*Lbs. Oz.*	°	*Feet.*	
June 8	614	1015	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 3 13 sand. 20 0	4	15	From right and front, 5 miles an hour.
June 8	615	1016		4 12		19 2 14 sand. 20 0	4	14	
June 8	616	1017		4 12		19 2 14 sand. 20 0	4	14	
June 8	617	1018		4 12		19 4 12 sand. 20 0	4	14	
June 8	618	1019		4 12		19 3 13 sand. 20 0	4	14	
June 8	619	1020		4 12		19 3 13 sand. 20 0	4	14	
June 8	620	1021		4 12		19 3 13 sand. 20 0	6	14	
June 8	621	1022		4 12		19 2 14 sand. 20 0	6	14	
June 8	622	1023		4 12		19 3 13 sand. 20 0	6	15	
June 8	623	1024		4 12		19 3 13 sand. 20 0	6	14	
June 8	624	1025		4 12		19 3 13 sand. 20 0	6	15	
June 8	625	1026		4 12		19 3 13 sand. 20 0	6	15	
June 8	626	1027		4 12		19 4 12 sand. 20 0	6	15	
June 8	627	1028		4 12		19 2 14 sand. 20 0	6	14	
June 8	628	1029		4 12		19 6 10 sand. 20 0	6	13	

Arsenal, at Sandy Hook, N. J., June 8, 1891—Continued.

endurance and range firing.]

Range.	Deflection.		Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	Right.	Left.		
Yards.	*Yards.*	*Yards.*		
2,548	.....	5	.....	
2,534	.....	4	.....	
2,553	.....	7	.....	
2,544	.....	7	.....	
2,554	.....	6	.....	
2,525	.....	6	.....	
3,277	6	.....	.....	
3,312	.....	1	.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; spiral-spring brake, clevis attachment, on left wheel.
3,290	.....	11	.....	Fired to sea. Cannon friction primers, model 1887.
3,294	.....	14	.....	
3,325	.....	14	.....	
3,307	.....	4	.....	
3,287	.....	4	.....	
3,254	.....	3	.....	
3,284	.....	14	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test gun for

Date.	No. of series.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Recoil.	Wind, strength and direction.
				Lbs. Oz.		*Lbs. Oz.*	°	*Feet.*	
P.M. June 8	629	1030	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 3 13 sand. 20 0	6	13	From right and front, 5 miles an hour.
June 8	630	1031		4 12		19 1 15 sand. 20 0	8	13	
June 8	631	1032		4 12		19 3 13 sand. 20 0	8	13	
June 8	632	1033		4 12		19 5 11 sand. 20 0	8	14	
June 8	633	1034		4 12		19 1 15 sand. 20 0	8	14	
June 8	634	1035		4 12		19 3 13 sand. 20 0	8	13	
June 8	635	1036		4 12		19 0 1 0 sand. 20 0	8	14	
June 8	636	1037		4 12		19 1 15 sand. 20 0	8	13	
June 8	637	1038		4 12		19 2 14 sand. 20 0	8	14	
June 8	638	1039		4 12		19 2 14 sand. 20 0	8	15	
June 8	639	1040		4 12		19 2 14 sand. 20 0	8	14	
June 8	640	1041		4 12		18 14 1 2 sand. 20 0	8	14	
June 8	641	1042		4 12		19 2 14 sand. 20 0	10	10	
June 8	642	1043		4 12		19 3 13 sand. 20 0	10	10	
June 8	643	1044		4 12		19 2 14 sand. 20 0	10	11	

Arsenal, at Sandy Hook, N. J., June 9, 1891—Continued.

endurance and range firing.]

Range.	Deflection.		Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	Right.	Left.		
Yards.	*Yards.*	*Yards.*		
3,278	.....	4	.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; spiral-spring brake, clevis attachment, on left wheel. Fired to sea. Cannon friction primers, model 1887. Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, of board for testing rifled cannon.
4,075	.....	3	.....	
4,027	.....	6	.....	
4,027	.....	6	.....	
3,990	.....	4	.....	
4,046	.....	6	.....	
3,967	.....	11	.....	
4,077	.....	3	.....	
.....	.....	.....	Angles lost.....	
4,012	.....	11	.....	
4,001	.....	11	.....	
3,989	7	.....	.....	
4,656	.....	7	.....	
4,674	.....	15	.....	
4,634	.....	9	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test gun for

Date.	No. of series.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Recoil.	Wind strength and direction.
P. M. June 8	644	1045	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	*Lbs. Oz.* 4 12	Shell (banded), experimental, lot 249.	*Lbs. Oz.* 19 1 15 sand. 20 0	° 10	*Feet.* 10	From right and front, 5 miles an hour.
June 8	645	1046		4 12		19 2 14 sand. 20 0	10	10	
June 8	646	1047		4 12		19 3 13 sand. 20 0	10	10	
June 8	647	1048		4 12		19 4 12 sand. 20 0	10	11	
June 8	648	1049		4 12		19 2 14 sand. 20 0	10	10	
June 8	649	1050		4 12		19 3 13 sand. 20 0	10	11	
June 8	650	1051		4 12		19 1 15 sand. 20 0	10	11	
June 9	651	1052		4 12		19 2 14 sand. 20 0	12	14	
June 9	652	1053		4 12		19 2 14 sand. 20 0	12	14	
June 9	653	1054		4 12		19 1 15 sand. 20 0	12	14	
June 9	654	1055		4 12		19 3 13 sand. 20 0	12	13	
June 9	655	1056		4 12		19 3 13 sand. 20 0	12	14	
June 9	656	1057		4 12		19 1 15 sand. 20 0	12	13	
June 9	657	1058		4 12		18 15 1 1 sand. 20 0	12	13	
June 9	658	1059		4 12		19 2 14 sand. 20 0	12	13	

Watervliet Arsenal, at Sandy Hook, N. J., June 8 and 9, 1891.

endurance and range firing.]

Range.	Deflection.		Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	Right.	Left.		
Yards.	*Yards.*	*Yards.*		
4,664	15	.....	.....	
4,670	.....	14	.....	
4,712	.....	10	.....	
4,690	3	.....	.....	
4,644	.....	7	.....	
4,669	.....	13	.....	
4,674	.....	4	.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; spiral-spring brake, clevis attachment, on left wheel.
.....	.....	.....	Angles lost	Fired to sea.
.....	.....	.....	Angles lost	Cannon friction primers, model 1887.
.....	.....	.....	Angles lost	Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, of board for testing rifled cannon.
.....	.....	.....	Angles lost	
.....	.....	.....	Angles lost	
.....	.....	.....	Angles lost	
5,245	.....	45	Line of fire changed. Gun sighted more to the left.	
.....	.....	.....	Right brake came off wheel in recoiling. Angles lost.	
5,276	25	.....	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test gun for

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Elevation.	Recoil.	Wind, strength and direction.
			Kind.	Weight.	Kind.	Weight.			
P. M.				*Lbs. Oz.*		*Lbs. Oz.*	°	*Feet.*	
June 9	659	1060	Laflin & Rand's I. K., lot 1; density 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	12	13	From right and front, 9 miles an hour.
June 9	660	1061		4 12		19 3 13 sand. 20 0	12	13	
June 9	661	1062		4 12		19 2 14 sand. 20 0	12	13	
June 9	662	1063		4 12		19 3 13 sand. 20 0	12	13	
June 9	663	1064		4 12		19 4 12 sand. 20 0	12	13	
June 9	664	1065		4 12		19 0 1 0 sand. 20 0	12	13	
June 9	665	1066		4 12		19 1 15 sand. 20 0	12	13	
June 9	666	1067		4 12		18 15 1 1 sand. 20 0	12	13	
June 9	667	1068		4 12		19 3 13 sand. 20 0	12	13	
June 9	668	1069		4 12		19 3 13 sand. 20 0	12	13	
June 9	669	1070		4 12		19 2 14 sand. 20 0	14	13	
June 9	670	1071		4 12		19 4 12 sand. 20 0	14	13	
June 9	671	1072		4 12		19 4 12 sand. 20 0	14	14	
June 9	672	1073		4 12		19 4 12 sand. 20 0	14	13	
June 9	673	1074		4 12		19 2 14 sand. 20 0	14	12	

Watervliet Arsenal, at Sandy Hook, N. J., June 9, 1891.

endurance and range firing.]

Range.	Deflection.		Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	Right.	Left.		
Yards.	*Yards.*	*Yards.*		
.....	.....	.....	Angles lost	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel, spiral-spring brake, clevis attachment, on left wheel. Fired to sea. Cannon friction primers, model 1887.
5,238	15	.....	.....	
5,177	24	.....	Time of flight, 16⅜ seconds.....	
5,214	35	.....	Time of flight, 16½ seconds.....	
5,187	17	.....	.....	
5,303	16	.....	Time of flight, 16½ seconds.....	
5,184	32	.....	Time of flight, 16½ seconds.....	
5,214	26	.....	Time of flight, 16½ seconds.....	Fired to sea. Cannon friction primers, model 1887. Gun easily loaded when at an elevation of 12°.
5,202	12	.....	Time of flight, 16½ seconds.....	
5,256	20	.....	Time of flight, 16½ seconds.....	
5,845	44	.....	Time of flight, 19½ seconds.....	
5,726	47	.....	.....	
5,705	90	.....	.....	Fired to sea. Cannon friction primers, model 1887. Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, of board for testing rifled cannon.
5,796	38	.....	.....	
5,842	23	.....	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test gun for

Date.	No. of series.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Recoil.	Wind, strength and direction.
P. M.				*Lbs. Oz.*		*Lbs. Oz.*	°	*Feet.*	
June 9	674	1075	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	14	13	From right and front, 9 miles an hour.
June 9	675	1076		4 12		19 1 15 sand. 20 0	14	12	
June 9	676	1077		4 12		19 3 13 sand. 20 0	14	13	
June 9	677	1078		4 12		19 2 14 sand. 20 0	14	13	
June 9	678	1079		4 12		19 4 12 sand. 20 0	14	13	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test Lieut. W. C. Rafferty's

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, —— feet from muzzle.	Pressure per square inch of bore.	Recoil.
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*	*Ft. In.*
June 12	1080	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	.....	.....	.....
June 12	1081		4 12		19 1 15 sand. 20 0	.....	.....	.....
June 12	1082		4 12		19 2 14 sand. 20 0	.....	.....	.....

Arsenal, at Sandy Hook, N. J., June 9, 1891—Continued.

endurance and range firing.]

Range.	Deflection.		Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	Right.	Left.		
Yards.	*Yards.*	*Yards.*		
5,758	24	.....	.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; spiral-spring brake, clevis attachment, on left wheel. Fired to sea. Cannon friction primers, model 1887. Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Capt. C. Shaler, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department, of board for testing rifled cannon.
5,894	5	.....	.....	
5,804	40	.....	Right brake came off wheel in recoiling.	
5,874	.....	2	.....	
5,779	29	.....	.....	

Watervliet Arsenal, at Sandy Hook, N. J., June 12, 1891.

method of friction recoil.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
A circular wooden block acting as a shoe placed under each wheel and fastened with 2½-inch rope passed through lunette ring. Carriage recoiled full length of platform and ran off. An iron plate acting as a shoe placed under each wheel and fastened with wire cable passed through lunette ring. Carriage recoiled full length of platform and ran off. A circular wooden block acting as a shoe placed under each wheel and fastened with 2½-inch rope passed through lunette ring. Carriage recoiled full length of platform and ran off.	Gun mounted on Buffington steel field carriage No. 4. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt. Present: Lieut. W. C. Rafferty, U. S. Army. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Feet.*	*Pounds.*	*Ft. In.*
June 13	1083	Laflin & Rand's I. K., lot 1.	4 12	Shell (banded), experimental, lot 249.	19 5 11 sand. 20 0	.....	.....	14 6
June 13	1084	Du Pont's sphero-hexagonal, lot 2, U. F.; density, 1.725; granulation, 116. Received June 13, 1891.	4 6		19 5 11 sand. 20 0	1,495 1,497	No. 3, 32, 100	14 0
June 13	1085		4 8		19 2 14 sand. 20 0	1,519 1,520	No. 3, 32, 325	14 6
June 13	1086		4 8		19 1 15 sand. 20 0	1,518 1,520 50+½	No. 3, 32, 380	14 0
A. M.								
June 20	1087	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12		19 2 14 sand. 20 0	.....	.....	14 0
June 20	1088	Du Pont's sphero-hexagonal, lot 3; density, 1.700; granulation, 123. Received June 19, 1891.	4 0		19 1 15 sand. 20 0	1,458 1,453	No. 3, 32, 060	15 0
June 20	1089		4 6		19 2 14 sand. 20 0	1,525 1,521	No. 3, 36, 800	16 0
June 20	1090		4 6		19 3 13 sand. 20 2	1,525 1,520	No. 3, 35, 520	16 0
P. M.								
June 20	1091	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12		19 2 14 sand. 20 0	.....	.....	16 0
	1092	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123. Received June 19, 1891.	4 6		19 1 15 sand. 20 0	1,527 Lost.	No. 3, 34, 670	16 0
June 20	1093		4 6		19 2 14 sand. 20 0	Lost	No. 3, 35, 920	16 0
June 20	1094		4 6		19 2 14 sand. 20 0	1,534 1,526	No. 3, 35, 870	16 0
June 20	1095		4 6		19 1 15 sand. 20 0	1,531 1,527 50+½	No. 3, 35, 380	16 0

Arsenal, at Sandy Hook, N. J., June 13 and 20, 1891.

to prove powder.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Warming charge	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; spiral-spring brake, clevis attachment, on left wheel. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
Warming charge	
Copper cylinders of 28,000 pounds initial compression and tables of 1890.	
First primer failed to ignite charge; head of primer blown off; base intact.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on left wheel; spiral-spring brake on right wheel. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt, section 1. Cartridge inserted with slight difficulty; diameter of cartridge bag too great. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 1089 and 1090.
First primer failed; wire pulled out	
Warming charge	
First primer failed to ignite charge. Head of primer blown off; base intact. Wires of second velocity target not cut.	Cartridge inserted with slight difficulty; diameter of bag too great. Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
Three primers failed to ignite charge. Head of primers blown off; base intact.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to

Date.	No. of fire.	Powder.		Projectile.		Including sand.	Instrumental velocity, — feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Pounds.*	*Lbs. Oz.*	*Feet.*	*Pounds.*
June 22	1096		4 12		20	14	----------	----------
June 22	1097		4 12		20	15	----------	----------
June 22	1098		4 12		20	15	----------	----------
June 22	1099		4 12		20	14	----------	----------
June 22	1100		4 12		20	15	----------	----------
June 22	1101		4 12		20	1 0	----------	----------
June 22	1102		4 12		20	14	----------	----------
June 22	1103		4 12		20	15	----------	----------
June 22	1104		4 12		20	12	----------	----------
June 22	1105		4 12		20	11	----------	----------
June 22	1106		4 12		20	15	----------	----------
June 22	1107		4 12		20	15	----------	----------
June 22	1108		4 12		20	13	----------	----------
June 22	1109		4 12		20	14	----------	No. 3, 34, 120
June 22	1110		4 12		20	15	----------	----------
June 22	1111		4 12		20	14	----------	----------
June 22	1112		4 12		20	13	----------	----------
June 22	1113		4 12		20	11	----------	----------
June 23	1114		4 12		20	15	----------	----------
June 23	1115		4 12		20	14	----------	No. 3, 34,630
June 23	1116		4 12		20	12	----------	----------
June 23	1117		4 12		20	13	----------	----------
June 23	1118		4 12		20	14	----------	No. 3, 33,600
June 23	1119		4 12		20	14	----------	----------
June 23	1120		4 12		20	13	----------	----------
June 23	1121		4 12		20	14	----------	----------
June 23	1122		4 12		20	14	----------	----------
June 23	1123		4 12		20	15	----------	----------
June 23	1124		4 12		20	14	1,530 1,535	No. 3, 34,300
June 23	1125		4 12		20	13	1,524 1,525	No. 3, 34,460
June 23	1126		4 12		20	14	----------	----------
June 23	1127		4 12		20	15	----------	----------
June 23	1128		4 12		20	14	----------	----------
June 23	1129		4 12		20	13	----------	----------
June 23	1130		4 12		20	14	----------	----------
June 23	1131		4 12		20	13	----------	----------
June 23	1132		4 12		20	12	----------	----------
June 23	1133		4 12		20	14	----------	----------
June 23	1134		4 12		20	15	----------	----------
June 23	1135		4 12		20	14	----------	----------
June 25	1136		4 12		20	14	----------	----------
June 25	1137		4 12		20	15	----------	----------
June 25	1138		4 12		20	14	----------	----------
June 25	1139		4 12		20	12	----------	----------
June 25	1140		4 12		20	11	----------	----------
June 25	1141		4 12		20	13	----------	----------
June 25	1142		4 12		20	14	----------	----------
June 25	1143		4 12		20	13	----------	----------
June 25	1144		4 12		20	14	----------	----------
June 25	1145		4 12		20	12	----------	----------
June 25	1146		4 12		20	11	----------	----------
June 25	1147		4 12		20	15	----------	----------
June 25	1148		4 12		20	14	----------	----------
June 25	1149		4 12		20	13	----------	----------
June 25	1150		4 12		20	15	----------	----------
June 25	1151		4 12		20	14	----------	----------
June 25	1152		4 12		20	14	----------	----------
June 25	1153		4 12		20	15	----------	----------
June 25	1154		4 12		20	14	----------	----------
June 25	1155		4 12		20	13	----------	----------
June 25	1156		4 12		20	14	----------	----------
June 25	1157		4 12		20	14	----------	----------
June 25	1158		4 12		20	15	----------	----------
June 25	1159		4 12		20	13	----------	----------
June 25	1160		4 12		20	14	----------	----------
June 25	1161		4 12		20	15	----------	----------
June 25	1162		4 12		20	14	----------	----------
June 25	1163		4 12		20	14	----------	----------
June 25	1164		4 12		20	15	----------	----------
June 25	1165	Laflin & Rand's L. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	13	----------	----------

Watervliet Arsenal, at Sandy Hook, N. J., June 22 to 25, 1891.

test gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
One bolt holding sponge and rammer rack to axle plate broken (right side).	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; spiral-spring brake, clevis attachment, on left wheel. Cannon friction primers, model 1887. Elevation, zero. All loose bolts and nuts in carriage tighte ned before this firing. Fired into field butt. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
Recoil excessive; platform sanded	
First primer failed; head blown off; base intact	
Lanyard broke	
Right brake jumped off wheel in recoiling, screw attaching key plate to left side of elevating screw box broken.	
Portion of metal above key plate broken off	
Right brake jumped off wheel in recoiling	
Right brake jumped off wheel in recoiling	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; spiral-spring brake, clevis attachment, on left wheel. Elevation, zero. Cannon friction primers, model 1887. Before this firing new screw put in key-plate of elevating screw box (left side). Fired into sand butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
Right brake jumped off wheel in recoiling	
Right brake jumped off wheel in recoiling	
Right brake jumped off wheel in recoiling	
Right brake jumped off wheel in recoiling	
Right brake jumped off wheel in recoiling	
Right brake jumped off wheel in recoiling	
Upper part of copper vent, measuring 1⅛ inches, blown out.	
First primer failed; head blown off; base intact.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; spiral-spring brake, clevis attachment, on left wheel. Elevation, zero. Cannon friction primers, model 1887. Fired into sand butt, section 1. Before this firing new copper vent put in gun. Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to

Date.	No. of fire.	Powder,		Projectile.		Including sand.	Instrumental velocity,—feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Pounds.*	*Lbs. Oz.*	*Feet.*	*Pounds.*
June 25	1166	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	20	14	.....	.....
June 25	1167		4 12		20	15	.....	.....
June 25	1168		4 12		20	14	.....	.....
June 25	1169		4 12		20	14	.....	.....
June 25	1170		4 12		20	12	.....	.....
June 25	1171		4 12		20	11	.....	.....
June 25	1172		4 12		20	14	.....	.....
June 25	1173		4 12		20	12	.....	.....
June 25	1174		4 12		20	11	.....	.....
June 25	1175		4 12		20	14	.....	.....
June 25	1176		4 12		20	15	.....	.....
A. M.								
June 29	1177		4 12		20	13	.....	.....
June 29	1178		4 12		20	14	.....	.....
June 29	1179		4 12		20	12	.....	.....
June 29	1180		4 12		20	14	.....	.....
June 29	1181		4 12		20	15	.....	.....
June 29	1182		4 12		20	11	.....	.....
June 29	1183		4 12		20	13	.....	.....
June 29	1184		4 12		20	12	.....	.....
June 29	1185		4 12		20	15	.....	.....
June 29	1186		4 12		20	11	.....	.....
June 29	1187		4 12		20	10	.....	.....
June 29	1188		4 12		20	12	.....	.....
June 29	1189		4 12		20	14	.....	.....
June 29	1190		4 12		20	15	.....	.....
June 29	1191		4 13		20	1 0	.....	.....
June 29	1192		4 12		20	14	.....	.....
June 29	1193		4 12		20	15	.....	.....
June 29	1194		4 12		20	15	.....	.....
June 29	1195		4 12		20	14	.....	.....
June 29	1196		4 12		20	14	.....	.....
June 29	1197		4 12		20	15	.....	.....
June 29	1198		4 12		20	12	.....	.....
June 29	1199		4 12		20	14	.....	.....
June 29	1200		4 12		20	13	.....	.....
June 29	1201		4 12		20	14	.....	.....
June 29	1202		4 12		20	12	.....	.....
June 29	1203		4 12		20	14	.....	.....
June 29	1204		4 12		20	15	.....	.....
June 29	1205		4 12		20	13	.....	.....
June 29	1206		4 12		20	14	.....	.....
June 29	1207		4 12		20	12	.....	.....
June 29	1208		4 12		20	15	.....	.....
June 29	1209		4 12		20	1 1	.....	.....
June 29	1210		4 12		20	15	.....	.....
June 29	1211		4 12		20	14	.....	.....
June 29	1212		4 12		20	14	.....	.....
June 29	1213		4 12		20	15	.....	.....
June 29	1214		4 12		20	1 1	.....	.....
June 29	1215		4 12		20	14	.....	.....
June 29	1216		4 12		20	15	.....	.....
June 29	1217		4 12		20	13	.....	.....
June 29	1218		4 12		20	12	.....	.....
June 29	1219		4 12		20	14	.....	.....
June 29	1220		4 12		20	15	.....	.....
June 29	1221		4 12		20	12	.....	.....
June 29	1222		4 12		20	11	.....	.....
June 29	1223		4 12		20	14	.....	.....
June 29	1224		4 12		20	13	.....	.....
June 29	1225		4 12		20	14	.....	.....
June 29	1226		4 12		20	15	.....	.....
June 29	1227		4 12		20	14	.....	.....
June 29	1228		4 12		20	1 1	.....	.....
June 29	1229		4 12		20	15	.....	.....
June 29	1230		4 12		20	13	.....	.....
June 29	1231		4 12		20	14	.....	.....
June 29	1232		4 12		20	14	.....	.....
P. M.								
June 29	1233		4 12	Lot 249	20	14	.....	.....

Arsenal, at Sandy Hook, N. J., June 25 and 29, 1891.

test gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; spiral-spring brake, clevis attachment, on left wheel.
	Elevation, zero.
	Cannon friction primers, model 1887.
	Fired into sand butt, section 1.
	Before this firing new copper vent put in gun.
	Firing conducted by the testing board. Present: Col. A. Mordecai, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
Right brake jumped off wheel in recoiling.	
Right brake jumped off wheel in recoiling.	
Right brake jumped off wheel in recoiling.	
Right brake jumped off wheel in recoiling.	
Right brake jumped off wheel in recoiling.	
Right brake jumped off wheel in recoiling.	
Right brake jumped off wheel in recoiling.	
Right brake jumped off wheel in recoiling.	
Part of bronze bushing at end of sleeve in old spiral-spring brake came off.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake, clevis attachment, on left wheel; old spiral-spring brake on right wheel.
	Elevation, zero.
	Cannon friction primers, model 1887.
	Fired into field butt, section 1.
	Powder put up in silk cartridge bag; cartridge inserted with slight difficulty; cartridge bag too large in diameter.
	Firing conducted by the testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
Right brake jumped off wheel in recoiling.	
Right brake jumped off wheel in recoiling.	
Right brake jumped off wheel in recoiling.	

Record of firing with 3.6-inch B. L. rifle (steel),

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′	*Feet.*	*Pounds.*
July 10	1234	Laflin & Rand's I. K., lot 1.	4 12	Shell (banded), experimental, lot 249.	19 3 13 sand. 20 0	.....	.....	.....
July 10	1235	Du Pont's sphero-hexagonal U. F., lot 4; density, 1.700; granulation, 123. Received July 9, 1891.	4 4		19 5 11 sand. 20 0	.....	Lost	No. 3, 36, 600
July 10	1236		4 6		19 2 14 sand. 20 0	.....	{ 1,536 1,536 }	No. 3, 32, 500
July 10	1237		4 6		19 3 13 sand. 20 0	.....	{ 1,542 1,539 }	No. 3, 34, 570
July 10	1238		4 6		19 6 10 sand. 20 0	.....	{ 1,544 1,543 }	No. 3, 34, 633
July 10	1239		4 6		19 2 14 sand. 20 0	.....	{ 1,538 1,536 }	No. 3, 34, 570
July 10	1240		4 6		19 1 15 sand. 20 0	.....	{ 1,545 1,541 }	No. 3, 34, 900
July 10	1241	Du Pont's sphero-hexagonal U. F., lot 5; density, 1.700; granulation, 123. Received July 9, 1891.	4 6		19 6 10 sand. 20 0	.....	{ 1,528 1,527 }	No. 3, 33, 646
July 10	1242		4 6		19 3 13 sand. 20 0	.....	{ 1,522 1,519 }	No. 3, 32, 480
P. M. July 10	1243	Laflin & Rand's I. K.; lot 1.	4 12		19 3 13 sand. 20 0	.....	.....	.....
July 10	1244	Du Pont's sphero-hexagonal U. F., density, 1.700; granulation, 123. Received July 9, 1891.	4 6		19 3 13 sand. 20 0	.....	{ 1,523 1,522 }	No. 3, 33, 900
July 10	1245		4 6		19 1 15 sand. 20 0	.....	{ 1,515 1,516 }	No. 3, 33, 677
July 10	1246		4 6		19 2 14 sand. 20 0	.....	{ 1,520 1,520 }	No. 3, 33, 200
July 10	1247	Du Pont's sphero-hexagonal U. F., lot 5; density, 1.700; granulation, 123. Received July 9, 1891.	4 6		19 3 13 sand. 20 0	.....	{ 1,555 1,554 }	No. 3, 37, 861
July 10	1248	Du Pont's sphero-hexagonal U. F., lot 6; density, 1.700; granulation, 123. Received July 9, 1891.	4 4		19 3 13 sand. 20 0	.....	{ 1,526 1,523 }	No. 3, 35, 900

Watervliet Arsenal, at Sandy Hook, N. J., July 10, 1891.

to prove powder.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
14	.....	Warming charge.....	
13	.....	Wires of second velocity target not cut.	
13	.....	.....	
14	.....	.....	
14	.....	.....	
14	.....	.....	
14	.....	.....	
13	.....	.....	
13½	.....	.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on left wheel; spiral-spring brake, clevis attachment, on right wheel. Cannon friction primers, model 1887. Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1890.
14	.....	.....	
14	.....	.....	
16	.....	Warming charge	
14	.....	.....	
13	.....	.....	
14	.....	.....	
14	.....	Right brake jumped off wheel in recoiling.	
13	.....	.....	

Record of firing with 3.6-inch B. L. rifle (steel), Watervliet

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′	*Feet.*	*Pounds.*
July 10	1249	Du Pont's sphero-hexagonal U. F., lot 6; density, 1.700; granulation, 123. Received July 9, 1891.	4 5	Shell (banded), experimental, lot 249.	19 1 15 sand. 20 0	.....	1,526 1,526	No. 3, 35, 640
July 10	1250		4 6		19 2 14 sand. 20 0	.....	1,545 1,538	No. 3, 36, 877
July 10	1251		4 6		19 3 13 sand. 20 0	.....	1,540 1,535	No. 3, 36, 700
July 10	1252		4 6		19 1 15 sand. 20 0	.....	1,547 1,541	No. 3, 38, 160
							$50+\frac{1}{2}^{0}$	
July 20	1253	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12		19 1 15 sand. 20 0	2 00	.....	.....
July 20	1254	Du Pont's sphero-hexagonal U. F., lot 7; density, 1.700; granulation, 123. Received July 18, 1891.	4 5		19 1 15 sand. 20 0	.....	1,517 1,511	No. 3, 33, 723
July 20	1255		4 6		19 2 14 sand. 20 0	.....	1,528 1,527	No. 3, 35, 125
A. M. July 21	1256	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12		19 2 14 sand. 20 0	.....	.....	.....
July 21	1257	Du Pont's sphero-hexagonal U. F., lot 7; density, 1.700; granulation, 123. Received July 18, 1891.	4 6		19 3 13 sand. 20 0	.....	1,530 1,530	No. 3, 34, 400
July 21	1258		4 6		19 4 12 sand. 20 0	.....	1,534 Lost.	No. 3, 35, 400
July 21	1259		4 6		19 4 12 sand. 20 0	.....	1,534 1,534	No. 3, 34, 946
July 21	1260		4 6		19 0 1 0 sand. 20 0	.....	1,534 1,532	No. 3, 35, 355

Arsenal, at Sandy Hook, N. J., July 10 to 21, 1891.

to prove powder.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
13	.....	.....	
14	.....	Right brake jumped off wheel in recoiling.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on left wheel; spiral-spring brake, clevis attachment on right wheel.
			Cannon friction primers, model 1887.
14	.....	Eye of clevis of right brake broken..	Fired into field butt, section 1.
			Copper cylinders 32,000 pounds initial compression and tables of 1890.
			Firing conducted by Lieut. C. B. Wheeler, assistant proof officer.
14	.....	Cartridge inserted with difficulty, due to cartridge bag being too large in diameter.	
12	From front, 10 miles an hour.	Warming charge; fired to sea	
14		First cartridge too large to enter chamber; sent back to magazine and changed.	
14		Cartridge inserted with slight difficulty.	
15	From front and left, 5 miles an hour.	Warming charge; fired into sand butt, section 6.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; bow-spring brake on left wheel.
			Cannon friction primers, model 1887.
			Unless bag tied tightly, tendency of sphero-hexagonal powder to wedge.
14		.....	Fired into field butt, section 2.
			Copper cylinders of 32,000 pounds initial compression and tables of 1890.
14		First primer failed to ignite charge; head of primer blown off; base intact; velocity wires of second target not cut.	
14		.....	
14		.....	

Record of firing with 3.6-inch B. L. rifle (steel),

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′	*Feet.*	*Pounds.*
July 21	1261	Du Pont's sphero-hexagonal U. F., lot 8; density, 1.700; granulation, 123. Received July 18, 1891.	4 6	Shell (banded), experimental, lot 249.	19 6 10 sand. 20 0	.....	1,499 1,498	No. 3, 32, 360
July 21	1262		4 6		19 1 15 sand. 20 0	.....	1,502 1,495	No. 3, 32, 520
July 21	1263		4 6		19 2 14 sand. 20 0	.....	1,501 1,501	No. 3, 32, 800
July 21	1264		4 6		19 3 13 sand. 20 0	.....	1,500 1,495	No. 3, 32, 320
July 21	1265		4 6		19 1 15 sand. 20 0	.....	1,499 1,497	No. 3, 32, 600

Watervliet Arsenal, at Sandy Hook, N. J., July 21, 1891.

to prove powder.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
14	From front and left, 5 miles an hour.	.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; bow-spring brake on left wheel. Cannon friction primers, model 1887 Fired into field butt, section 2. After round 1255 cartridge bags made smaller in diameter and longer, the length now being 12½ inches. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer. Gun star-gauged after round 1265, July 28, 1891, by Lieut. W. W. Gibson, Ordnance Department.
14		.....	
14		.....	
14		.....	
14		.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing. to test

	No. of fire.	Powder.		Projectile.		Including sand.	Elevation.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Pounds.*	*Ounces.*	° ′	*Pounds.*
A. M.....	1266	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell rebanded.	20	10	.....	.....
	1267		4 12		20	13	.....	.....
	1268		4 12		20	13	.....	.....
	1269		4 12		20	12	.....	.....
	1270		4 12		20	14	.....	.....
	1271		4 12		20	13	.....	.....
	1272		4 12		20	13	.....	.....
	1273		4 12		20	10	.....	.....
	1274		4 12		20	13	.....	.....
	1275		4 12		20	14	.....	.....
	1276		4 12		20	10	.....	.....
	1277		4 12		20	13	.....	.....
	1278		4 12		20	11	.....	.....
	1279		4 12		20	13	.....	.....
	1280		4 12		20	12	.....	.....
	1281		4 12		20	12	.....	.....
	1282		4 12		20	14	.....	.....
	1283		4 12		20	11	.....	.....
	1284		4 12		20	11	.....	.....
	1285		4 12		20	12	.....	No. 3, 34, 875
	1286		4 12		20	13	.....	.....
	1287		4 12		20	11	.....	.....
	1288		4 12		20	12	.....	.....
	1289		4 12		20	15	.....	.....
	1290		4 12		20	13	.....	.....
	1291		4 12		20	12	.....	.....
	1292		4 12		20	13	.....	.....
	1293		4 12		20	13	.....	.....
	1294		4 12		20	14	.....	.....
	1295		4 12		20	13	.....	.....
	1296		4 12		20	13	.....	.....
	1297		4 12		20	12	.....	.....
	1298		4 12		20	11	.....	.....
	1299		4 12		20	11	.....	.....
	1300		4 12		20	11	.....	.....
	1301		4 12		20	11	.....	.....
	1302		4 12		20	10	.....	.....
	1303		4 12		20	10	.....	.....
	1304		4 12		20	12	.....	.....
	1305		4 12		20	11	.....	.....
P. M.....	1306		4 12		20	11	.....	.....
	1307		4 12		20	12	.....	.....
	1308		4 12		20	13	.....	.....
	1309		4 12		20	12	.....	.....
	1310		4 12		20	13	.....	.....
	1311		4 12		20	13	.....	.....
	1312		4 12		20	12	.....	.....
	1313		4 12		20	12	.....	.....
	1314		4 12		20	12	.....	.....
	1315		4 12		20	11	.....	.....
	1316		4 12		20	16	.....	.....
	1317		4 12		20	13	.....	.....
	1318		4 12		20	12	.....	.....
	1319		4 12		20	11	.....	.....
	1320		4 12		50	14	.....	.....
	1321		4 12		20	.....	.....	.....
	1322		4 12		20	11	.....	.....
	1323		4 12		20	12	.....	.....
	1324		4 12		20	11	.....	.....
	1325		4 12	Shell banded.	20	13	.....	.....
	1326		4 12		20	13	.....	.....
	1327		4 12	Shell rebanded.	20	12	.....	.....
	1328		4 12		20	10	.....	.....
	1329		4 12		20	11	.....	.....
	1330		4 12		20	12	.....	.....
	1331		4 12		20	14	.....	No. 3, 33, 140
	1332		4 12		20	12	.....	.....
	1333		4 12		20	13	.....	.....
	1334		4 12		20	13	.....	.....
	1335		4 12		20	12	.....	.....
	1336		4 12		20	12	.....	.....
	1337		4 12		20	11	.....	.....
	1338		4 12		20	10	.....	.....

Watervliet Arsenal, at Sandy Hook, N. J., August 5, 1891.

gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; bow-spring brake on left wheel. Cannon friction primers, model 1887. Fired into field butt. All loose nuts and bolts in carriage tightened up before this firing. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Fired to sea from round 1307 to 1338, inclusive. Firing conducted by the testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
Left bolt attaching axle plate to transom broken off.	
Screw on left side of elevating-screw box holding key broken.	
Powder put up in silk cartridge-bag	

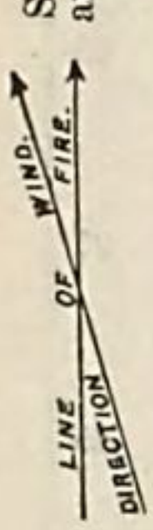
Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to determine coefficient

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity, 125 feet from muzzle.	Readings of thermometer.	Recoil.
		Kind.	Weight.	Kind.	Weight.				
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	′	*Feet.*	°	*Feet.*
Aug. 12	1339	Du Pont's sphero-hexagonal V. F., lot 3; density, 1.700; granulation, 123.	4 6	Du Pont's sphero-hexagonal V. F., lot 3; density, 1.700; granulation, 123.	19 2 14 sand. 20 0	30	1540 1541	89	11
Aug. 12	1340		4 6		19 1 15 sand. 20 0	10	1531 1531	88	11
Aug. 12	1341		4 6		19 2 14 sand. 20 0	10	Lost. 1511	81	11
A. M.									
Aug. 13	1342		4 12		19 1 15 sand. 20 0	10	1491 1491	79	12
Aug. 13	1343		4 12		19 2 14 sand. 20 0	10	1514 1514	78	12
Aug. 13	1344		4 12	Shell (banded), experimental, lot 249.	19 2 14 sand. 20 0	10	1527 1526	77	11
Aug. 13	1345	Laflin & Rand's I. K., lot 30.	4 12		19 3 13 sand. 20 0	10	1514 1514	79	12
Aug. 13	1346	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12		19 1 15 sand. 20 0	10	1518 1514	79	12
Aug. 13	1347		4 12		19 2 14 sand. 20 0	10	1509 1504	79	13
Aug. 13	1348		4 12		19 2 14 sand. 20 0	10	1514 1505	79	12
Aug. 13	1349		4 12		19 3 13 sand. 20 0	10	1526 1516	79	12
Aug. 13	1350		4 12		19 1 15 sand. 20 0	10	1518 1508	80	12
P. M.									
Aug. 13	1351		4 12		19 2 14 sand. 20 0	10	.....	.....	.....
							Velocity, 804 feet from muzzle.		
Aug. 13	1352		4 12		19 2 14 sand. 20 0	10	1433 1419	84	12

Watervliet Arsenal, at Sandy Hook, N. J., August 12 and 13, 1891.

of reduction in ballistic formulæ.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Six miles an hour. 	Barometer at 3 p. m., 30″.01	
	Barometer at 3:30 p. m., 30″.00	
	Barometer at 4 p. m., 29″.99	
Fourteen miles an hour.	Barometer at 9:15 a. m., 30″.11	Gun mounted on Buffington steel field carriage No. 4. Old spiral spring brake on right wheel; bow-spring brake on left wheel. Cannon friction primers, model 1887. Fired into sand butt, section 4.
	Barometer at 9:30 a. m., 30″.11	
	Barometer at 9:45 a. m., 30″.11	
	Barometer at 10 a. m., 30″.11	
	Barometer at 10:25 a. m., 30″.11	
	Barometer at 10:45 a. m., 30″.11	
	Barometer at 11:15 a. m., 30″.11	
	Barometer at 11:30 a. m., 30″.11	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on left wheel; bow-spring brake on right wheel. Cannon friction primers, model 1887. Fired into sand butt, section 4. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
	Barometer at 11:45 a. m., 30″.11	
	Warming charge	
	Barometer at 1:50 p. m., 30″.11	

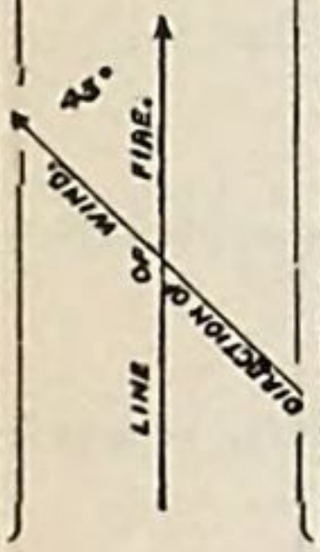
Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to determine coefficient

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity, 804 feet from muzzle.	Readings of thermometer.	Recoil.
		Kind.	Weight.	Kind.	Weight.				
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	′	*Feet.*	°	*Feet.*
Aug. 13	1353	Laflin & Rand's I. K., lot 1; density, 1.170; granulation, 2,560.	4 12	Shell (banded), experimental, lot 249.	19 4 12 sand. 20 0	10	Lost.	85	12
Aug. 13	1354		4 12		19 2 14 sand. 20 0	10	Lost.	85	12
Aug. 13	1355		4 12		19 1 15 sand. 20 0	10	1431 1413	85	12
Aug. 13	1356		4 12		19 2 14 sand. 20 0	10	1431 Lost.	85	12
Aug. 13	1357		4 12		19 1 15 sand. 20 0	10	Lost.	85	12
Aug. 13	1358		4 12		19 2 14 sand. 20 0	10	Lost. 754+$\frac{10}{2}$	84	12

Watervliet Arsenal, at Sandy Hook, N. J., August 13, 1891.

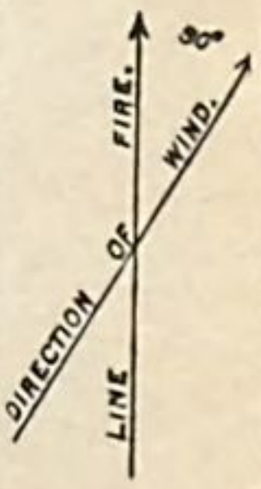
of reduction in ballistic formulæ.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Fourteen miles an hour. 	Barometer at 2 p. m., 30″.11	
	Barometer at 2:30 p. m., 30″.11	
	Barometer at 3 p. m., 30″.10	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on left wheel; bow-spring brake on right wheel.
	Barometer at 3:30 p. m., 30.″10	Cannon friction primers, model 1887. Fired into sand butt, section 4. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
	Barometer at 4 p. m., 30″.10	
	Barometer at 4:30 p. m., 30″.10	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to

	No. of fire.	Powder.		Projectile.		Elevation.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs. Oz.*	°	*Feet.*	
A. M.	1359	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	4 12	Shell (branded), experimental, lot 249.	19 1 15 sand. 20 0	4	14	Eight miles an hour.
	1360		4 12		19 2 14 sand. 20 0	4	14	
	1361		4 12		19 2 14 sand. 20 0	4	14	
	1362		4 12		19 3 13 sand. 20 0	6	14	
	1363		4 12		19 2 14 sand. 20 0	6	11½	
	1364		4 12		19 1 15 sand. 20 0	8	11	
	1365		4 12		19 3 13 sand. 20 0	8	11	
	1366		4 12		19 2 14 sand. 20 0	10	9	
	1367		4 12		19 1 15 sand. 20 0	10	10	
	1368		4 12		19 2 14 sand. 20 0	12	11	
	1369		4 12		19 3 13 sand. 20 0	12	12	
P. M.	1370		4 12		19 2 14 sand. 20 0	14	11½	
	1371		4 12		19 4 12 sand. 20 0	14	11½	
	1372		4 12		19 5 11 sand. 20 0	16	11	
	1373		4 12		19 1 15 sand. 20 0	.....	17	



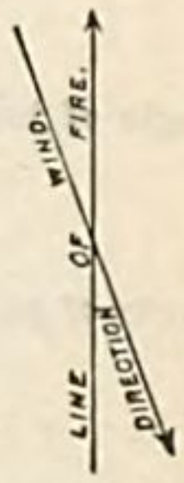
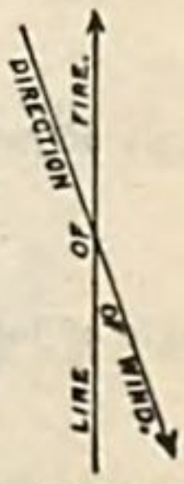
Watervliet Arsenal, at Sandy Hook, N. J., August 21, 1891.

determine jump of gun.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Angle of jump, 15′ 20″	
Angle of jump, 18′ 50″	
Angle of jump, 18′ 40″	
Angle of jump, 18′ 00″	
Angle of jump, 13′ 10″	
Angle of jump, 12′ 20″	
Angle of jump, 11′ 20″	
Angle of jump, 12′ 00″	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Gun carriage resting on platform of 4-inch yellow pine, laid lengthwise on sleepers. Distance of target from gun, 50 feet. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
Angle of jump, 12′ 40″	
Angle of jump, 11′ 50″	
Angle of jump, 12′ 40″	
Angle of jump, lost	
Angle of jump, 13′ 00″	
Angle of jump, 12′ 40″	
Angle of jump, 12′ 30″	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to compare residue

	No. of fire.	Powder.		Projectile.		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		
			Lbs. Oz.		*Lbs. Oz.*	*Feet.*	
	1374		4 12		19 1 15 sand. 20 0	18	
	1375		4 12		19 4 12 sand. 20 0	17	
	1376		4 12		19 9 7 sand. 20 0	17	
	1377		4 12		19 12 4 sand. 20 0	17	
	1378		4 12		19 14 2 sand. 20 0	16	
	1379		4 12		19 0 1 0 sand. 20 0	16	
	1380		4 12		19 10 6 sand. 20 0	14	
	1381		4 12		19 10 6 sand. 20 0	13	
	1382		4 12		19 3 13 sand. 20 0	14	
A. M.....	1383	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 12	Shell rebanded.	19 1 15 sand. 20 0	13	Eight miles an hour.
	1384		4 12		19 4 12 sand. 20 0	14	
	1385		4 12		19 9 7 sand. 20 0	15	
	1386		4 12		19 4 12 sand. 20 0	13	
	1387		4 12		19 3 13 sand. 20 0	12	
	1388		4 12		19 2 14 sand. 20 0	15	
	1389		4 12		19 2 14 sand. 20 0	17	
	1390		4 12		19 2 14 sand. 20 0	16	

Watervliet Arsenal, at Sandy Hook, N. J., August 24, 1891.

of silk cartridge bag to that of serge.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
First primer failed to ignite charge; head of primer blown off; base intact.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt, section 2. Powder put up in silk cartridge bags. Residue removed from chamber and breech mechanism after each round. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
Shoe on bow spring on left wheel broken; replaced by old spiral-spring brake.	
	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on right wheel; old spiral-spring brake on left wheel. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt, section 2. Powder put up in silk cartridge bag. Residue removed from chamber and breech mechanism after each round. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
Left brake jumped off wheel in recoiling	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test Merriam base

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Fuse No.
			Lbs. Oz.		*Lbs. Oz.*	′	
P. M.....	1391	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	2 6	Shell altered to receive fuse, lot 249.	17 14 1 1 fuse. 6 powder, bursting charge. 19 5	30	66
	1392		4 12		17 15 1 1 fuse, 7½ powder, bursting charge. 19 7½	15	69

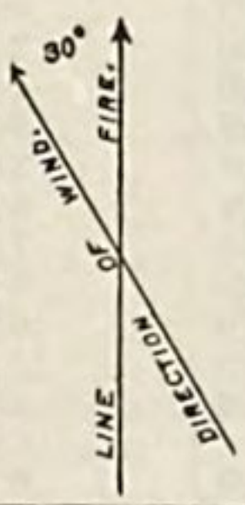
Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to compare residue of

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Recoil.	Wind, strength and direction.
			Lbs. Oz.		*Lbs. Oz.*	*et.*	
A. M.....	1393	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 12	Shell rebanded.	19 12 4 sand. 20 0	16	Six miles an hour.
	1394		4 12		19 12 4 sand. 20 0	14	
	1395		4 12		19 0 1 0 sand. 20 0	16	
	1396		4 12		19 11 5 sand. 20 0	14	
	1397		4 12		19 4 12 sand. 20 0	14	
	1398		4 12		19 0 1 0 sand. 20 0	14	
	1399		4 12		19 0 1 0 sand. 20 0	14	
	1400		4 12		19 12 4 sand. 20 0	14	

Watervliet Arsenal, at Sandy Hook, N. J., August 25, 1891.

percussion fuse (automatic)].

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*			
No. 3, 12,525	.....	Ten miles an hour. 	Shell struck the ground about 500 yards from gun and burst; copper cylinders of 9,000 pounds initial compression and tables of 1890.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on right wheel; bow-spring brake on left wheel. Cannon friction primers, model 1887. Fired down the beach. Fuses had medium weight head. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
No. 3, 34,460	.....		Shell burst in gun; large fragments struck the ground about 500 yards from gun; copper cylinders of 32,000 pounds initial compression and tables of 1890.	

Watervliet Arsenal, at Sandy Hook, N. J., August 27, 1891.

silk cartridge bag to that of serge.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
.....	
.....	
.....	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on left wheel; old spiral-spring brake on right wheel. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt, section 2. Powder put up in silk cartridge bags. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
.....	
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.....	
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.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to compare residue of

	No. of fire.	Powder.		Projectile.		Including sand.	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs.*	*Lbs. Oz.*	*Feet.*	
P. M.....	1401	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 12	Shell re-rebanded.	20	7	15	Six miles an hour.
	1402		4 12		20	3	14	
	1403		4 12		20	2	14	
	1404		4 12		20	12	15	
	1405		4 12		20	1 0	13	
	1406		4 12		20	14	14	
	1407		4 12		20	6	14	
	1408		4 12		20	4	14	
	1409		4 12		20	3	14	
	1410		4 12		20	5	15	
	1411		4 12		20	2	14	
	1412		4 12		20	4	13	
	1413		4 12		20	9	14	
	1414		4 12		20	3	15	
	1415		4 12		20	5	16	
	1416		4 12		20	7	14	
	1417		4 12		20	6	14	
	1418		4 12		20	10	14	
	1419		4 12		20	12	14	
	1420		4 12		20	4	14	
	1421		4 12	Shell (banded), experimental, lot 249.	20	1 0	14	
	1422		4 12		20	4	14	
	1423		4 12		20	6	14	
	1424		4 12		20	13	14	
	1425		4 12		20	8	17	

Arsenal, Sandy Hook, N. J., August 27, 1891—Continued.

serge cartridges bag to that of silk.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumptian of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brake on left wheel; bow-spring brake on right wheel. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt, section 2. Powder put up in serge cartridge bags. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
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.....	
.....	
.....	
Left brake jumped off wheel on recoiling.....	
Left brake jumped off wheel on recoiling.....	
.....	
.....	
.....	
.....	
.....	
.....	
First primer failed to ignite charge. Head of primer blown off; base intact.	
.....	
.....	
.....	
.....	
.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test

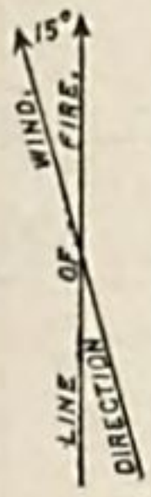
	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, —— feet from muzzle.	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*	*Feet.*	*Pounds.*
P. M.	1426	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 12	Condemned shell.	18 8 1 8 sand. 20 0	.....	.....
	1427		4 12		18 10 1 6 sand. 20 0	.....	.....
	1428		4 12		19 0 1 0 sand. 20 0	.....	.....
	1429		4 12		18 14 1 2 sand. 20 0	.....	.....
	1430		4 12		18 13 1 3 sand. 20 0	.....	.....
	1431		4 12		18 14 1 2 sand. 20 0	.....	.....
	1432		4 12		19 0 1 0 sand. 20 0	.....	.....
	1433		4 12		18 12 1 4 sand. 20 0	.....	.....
	1434		4 12		18 14 1 2 sand. 20 0	1,505 1,514	No. 3, 33,060
	1435		4 12		19 0 1 0 sand. 20 0	1,500 1,507	No. 3, 32,970

[Object of firing, to

P. M.	1436	Du Pont's V. Q. Received August 8, 1891. Density, 1.775; granulation, 3,908.	4 4	Condemned shell.	19 0 1 0 sand. 20 0	1,384 1,386	No. 3, less than 32,000.
	1437		4 12		19 0 1 0 sand. 20 0	1,462 1,471	No. 3, less than 32,000.
	1438		4 12		19 0 1 0 sand. 20 0	1,459 1,468 $50+\frac{15}{2}^{0}$	No. 3, 28,280

Watervliet Arsenal, at Sandy Hook, N. J., September 9, 1891.

gun for endurance.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
16	Ten miles an hour.	Left brake jumped off wheel in recoiling.	
14		----------	
16		Left brake jumped off wheel in recoiling.	
16		Left brake jumped off wheel in recoiling.	
14		----------	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on right wheel; old spiral-spring brake on left wheel. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt, section 1.
14		----------	Firing conducted by the testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
14		First primer failed to ignite charge. Head of primer blown off; base intact.	
14		----------	
14		Copper cylinders of 32,000 pounds initial compression and tables of 1890.	
13		Left brake jumped off wheel in recoiling. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	

prove powder.]

14	Ten miles an hour.	Copper cylinders of 32,000 pounds initial compression and tables of 1890.	
15		Copper cylinders of 32,000 pounds initial compression and tables of 1890.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on right wheel; old spiral-spring brake on left wheel. Elevation. zero. Cannon friction primers, model 1887. Elevation, zero. Fired into field butt, section 1.
15		Copper cylinders of 28,000 pounds initial compression and tables of 1890.	

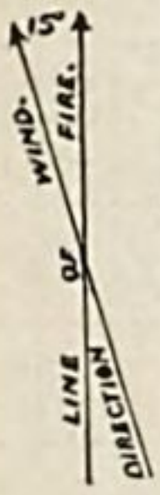
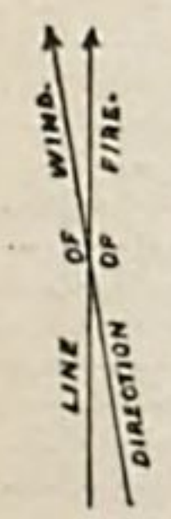
Record of firing with 3.6-inch B. L. rifle (steel), No 1, Watervliet

[Object of firing, to test

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Instrumental velocity, —— feet from muzzle.	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*	*Feet.*	*Pounds.*
P. M.....	1439	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 14	Condemned shell.	18 14 1 2 sand. 20 0	1,521 1,534	No. 3, 32,000
	1440		4 15		18 14 1 2 sand. 20 0	1,525 1,533	No. 3, less than 32,000.
	1441		5 0		19 0 1 0 sand. 20 0	1,552 1,560	No. 3, 34,826
	1442		5 0		19 0 1 0 sand. 20 0	3,541 1,550	No. 3, 32,700
	1443		5 0		18 14 1 2 sand. 20 0	$50+\frac{15}{2}^{o}$	.....
	1444		5 0		18 14 1 2 sand. 20 0	.....	.....
	1445		5 0		19 0 1 0 sand. 20 0	.....	.....
	1446		5 0		18 14 1 2 sand. 20 0	.....	.....
	1447		5 0		18 13 1 3 sand. 20 0	.....	.....
	1448		5 0		18 12 1 4 sand. 20 0	.....	.....
	1449		5 0		19 0 1 0 sand. 20 0	.....	.....
	1450		5 0		18 12 1 4 sand. 20 0	.....	.....
	1451		5 0		18 13 1 3 sand. 20 0	.....	.....
	1452		5 0		18 15 1 1 sand. 20 0	.....	.....
	1453		5 0		18 13 1 3 sand. 20 0	.....	.....
	1454		5 0		18 14 1 2 sand. 20 0	.....	.....

Arsenal, at Sandy Hook, N. J., September 9, 1891—Continued.

gun for endurance.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
14		.....	
14		.....	
13		Copper cylinders of 28,000 pounds initial compression and tables of 1890.	
14		.....	
16		Left brake jumped off wheel in recoiling.	
14		.....	
14		.....	Gun mounted on Buffington steel field carriage No. 4. Bow spring-brake on right wheel; old spiral-spring brake on left wheel. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt, section 1.
15		.....	Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 1439, 1440, and 1442.
14		.....	Firing conducted by the testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
14	Ten miles an hour.	First primer failed to ignite charge; head of primer blown off; base in tact.	
14		Shoe of brake on left wheel bent; brake removed; wheels lashed to lunette ring with rope.	
13		.....	
14		.....	
14		.....	
14		.....	
14		.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to

	No. of fire.	Powder.		Projectile.		Including sand.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs. Oz.*	*Lbs. Oz.*	*Feet.*	*Pounds.*
A. M	1455	Laflin & Rand's I. K., lot 1; granulation, 2,560; density, 1.710.	4 12	Condemned shell.	20 0	15	1,494 Lost.	No. 3, 29, 200
	1456		5 0		20 0	1 2	1,534 1,537	No. 3, 32, 600
	1457		5 0		20 0	1 1	.....	.....
	1458		5 0		20 0	1 2	.....	.....
	1459		5 0		20 0	1 2	.....	.....
	1460		5 0		20 0	1 3	.....	.....
	1461		5 0		20 0	1 0	.....	.....
	1462		5 0		20 0	15	.....	.....
	1463		5 0		20 0	1 0	.....	.....
	1464		5 0		20 0	1 0	.....	.....
	1465		5 0		20 0	1 0	.....	.....
	1466		5 0		20 0	1 0	.....	.....
	1467		5 0		20 0	1 0	.....	.....
	1468		5 0		20 0	1 0	.....	.....
	1469		5 0		20 0	1 0	.....	.....
	1470		5 0		20 0	1 0	.....	.....
	1471		5 0		20 0	1 2	.....	.....
	1472		5 0		20 0	1 2	.....	.....
	1473		5 0		20 0	1 1	.....	.....
	1474		5 0		20 0	1 2	.....	.....
	1475		5 0		20 0	1 3	.....	.....
	1476		5 0		20 0	1 4	.....	.....
	1477		5 0		20 0	1 3	.....	.....
	1478		5 0		20 0	1 2	.....	.....
	1479		5 0		20 0	1 1	.....	.....
	1480		5 0		20 0	1 2	.....	No. 3, 33, 340
	1481		5 0		20 0	1 3	.....	.....
	1482		5 0		20 0	1 4	.....	.....
	1483		5 0		20 0	1 4	.....	.....
	1484		5 0		20 0	1 3	.....	.....
	1485		5 0		20 0	1 1	.....	.....
	1486		5 0		20 0	1 2	.....	.....
	1487		5 0		20 0	1 3	.....	.....
	1488		5 0		20 0	1 2	.....	.....
	1489		5 0		20 0	1 0	.....	.....
	1490		5 0		20 0	1 0	.....	.....
	1491		5 0		20 0	1 2	.....	.....
	1492		5 0		20 0	1 3	.....	.....
	1493		5 0		20 0	1 2	.....	.....
	1494		5 0		20 0	15	.....	.....
	1495		5 0		20 0	15	.....	.....
	1496		5 0		20 0	1 0	.....	.....
	1497		5 0		20 0	1 1	.....	.....
	1498		5 0		20 0	1 2	.....	.....
	1499		5 0		20 0	1 2	.....	.....
	1500		5 0		20 0	1 0	.....	.....
	1501		5 0		20 0	1 2	.....	.....
	1502		5 0		20 0	1 1	.....	.....
	1503		5 0		20 0	1 2	.....	.....
	1504		5 0		20 0	1 3	.....	.....
	1505		5 0		20 0	1 1	.....	.....
P. M	1506	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5 0	Shell rebanded.	20 0	1 2	.....	.....
	1507		5 0		20 0	1 0	.....	.....
	1508		5 0		20 0	1 0	.....	.....
	1509		5 0		20 0	1 0	.....	.....
	1510		5 0		20 0	1 2	.....	.....
	1511		5 0		20 0	1 3	.....	.....
	1512		5 0		20 0	1 4	.....	.....
	1513		5 0		20 0	1 2	.....	.....
	1514		5 0		20 0	1 3	.....	.....
	1515		5 0		20 0	1 4	.....	.....
	1516		5 0		20 0	1 4	.....	.....
	1517		5 0		20 0	1 5	.....	.....
	1518		5 0		20 0	1 1	.....	.....
	1519		5 0		20 0	1 2	.....	.....
	1520		5 0		20 0	1 1	.....	.....
	1521		5 0		20 0	1 1	.....	.....
	1522		5 0		20 0	1 0	.....	.....
	1523		5 0		20 0	1 0	.....	.....

Watervliet Arsenal, at Sandy Hook, N. J., September 10, 1891.

test gun for endurance.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
12	Ten miles an hour.		Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on right wheel; old spiral-spring brake on left wheel.
17			Elevation, zero.
14			Cannon friction primers, model 1887.
14			Brake bent in previous firing straightened and replaced before this firing.
14			Fired into field butt, section 2.
14			Copper cylinders of 28,000 pounds initial compression and tables of 1890.
14			Firing conducted by the testing board.
14			Present: Capt. Heath, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
14		First primer failed to ignite charge	
14		Left brake jumped off wheel in recoiling.	
14			
14			
14		Left brake jumped off wheel in recoiling.	
14			
14			
14			
14			
14			
14			
14			
14			
14			
14		Left brake jumped off wheel in recoiling.	
14			
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14	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Including sand.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*	*Lbs. Oz.*	*Feet.*	*Pounds.*
P. M.....	1524	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2.360.	5 0	Shell (banded), lot 326.	20 0	1 1	.....	.....
	1525		5 0		20 0	1 2	.....	.....
	1526		5 0		20 0	1 2	.....	.....
	1527		5 0		20 0	1 1	.....	.....
	1528		5 0		20 0	1 2	.....	.....
	1529		5 0		20 0	1 3	.....	.....
	1530		5 0		20 0	1 2	.....	.....
	1531		5 0		20 0	1 2	.....	.....
	1532		5 0		20 0	1 1	.....	.....
	1533		5 0		20 0	1 3	.....	.....
	1534		5 0		20 0	1 1	.....	.....
	1535		5 0		20 0	1 0	.....	.....
	1536		5 0		20 0	1 0	.....	.....
	1537		5 0		20 0	15	.....	.....
	1538		5 0		20 0	15	.....	.....
	1539		5 0		20 0	1 1	.....	.....
	1540		5 0		20 0	1 15	.....	.....
	1541		5 0		20 0	1 2	.....	.....
	1542		5 0		20 0	1 1	.....	.....
	1543		5 0		20 0	1 3	.....	.....
	1544		5 0		20 0	1 2	.....	.....
	1545		5 0		20 0	1 1	.....	.....

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, experiments with Merriam fuses to test

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	No. of fuse.	Elevation.	Wind allowance (points right).	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*		° ′		*Pounds.*
P. M....	1546	Lot 7.	3 8	.....	18 13 1 3 sand. 20 0	67	.....	.....	No. 3, 21, 635

[Object of firing, test for

P. M....	1547	Laflin & Rand's I. K.; density, 1.710; granulation, 2,360.	4 12	Shell, lot 326.	18 14 1 2 sand. 20 0	67	.....	.....	No. 3, 36, 660
	1548		4 12		18 15 1 1 sand. 20 0	67	.....	.....	No. 3, 35, 600
	1549		4 12		18 14 1 2 sand. 20 0	67	.....	.....	No. 3, 36, 500
	1550		4 12		18 14 1 2 sand. 20 0	67	.....	.....	No. 3, 36, 120

Arsenal, at Sandy Hook, N. J., September 10, 1891—Continued.

gun for endurance.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.	Ten miles an hour. LINE OF FIRE. DIRECTION OF WIND.		Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on right wheel; old spiral-spring brake on left wheel. Cannon fricton primers, model 1887. Fired into field butt, section 2. Firing conducted by the testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.

Watervliet Arsenal, at Sandy Hook, N. J., September 11, 1891.

strength of base, tightening of pistons and threads.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet. 12	Four miles an hour.	Fuse housing with front end closed with plug containing wax to receive force of retainers at instant of release. Ball released; retainers showed slight indentation in wax. No leakage in pistons or threads.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on right wheel; old spiral-spring brake on left wheel.

strength of base under full charge.]

12	Four miles an hour. LINE OF FIRE. DIRECTION OF WIND.	Ball-retainers and closing plug removed; base slightly depressed; housing upset; no leakage shown.	Fuse in housing placed in base of cartridge bag. Friction primers, long. Fired to sea.
12		Ball-retainers and closing plug removed; base reduced by $\frac{1}{16}$-inch; slight depression.	Copper cylinders of 9,000 pounds initial compression and tables of 1887 used in round 1546.
12		Ball-retainers and closing plug removed; base reduced by $\frac{5}{32}$-inch; base depressed about $\frac{1}{100}$ at center.	Copper cylinders of 28,000 pounds initial compression, and tables of 1890 used in round 1547.
12		Ball-retainers and closing plug removed; base reduced by $\frac{7}{32}$-inch; base depressed.	Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in rounds 1548 to 1550, inclusive. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.

Record of firing with 3.6-inch B. L. rifle (steel), No 1, Watervliet

[Object of firing, to test

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	No. of fuse.	Elevation.	Wind allowance (points right).	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*		° ′		*Pounds.*
P. M....	1551	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	4 6	Shell, lot 326.	19 1 15 sand. 20 0	.....	5 10	1	.....
	1552		4 6		18 13 1 3 sand. 20 0	.....	5 8	3½	.....
	1553		4 6		18 14 1 2 sand. 20 0	.....	5 5	4	.....
	1554		4 6		19 2 14 sand. 20 0	.....	5 3	5	.....
	1555		4 6		19 0 1 0 sand. 20 0	.....	5 10	1	.....
	1556		4 6		19 0 1 0 sand. 20 0	.....	5 13	¼	.....
	1557		4 6		18 15 1 1 sand. 20 0	.....	5 16	¼	.....
	1558		4 6		18 14 1 2 sand. 20 0	.....	4 40	2	.....
	1559		4 6		18 14 1 2 sand. 20 0	.....	4 38	½	.....
	1560		4 6		18 15 1 1 sand. 20 0	.....	4 38	½	.....

Arsenal, at Sandy Hook, N. J., September 11, 1891—Continued.

gun for endurance and accuracy.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
10	.....	Sighting shot. Struck 10 yards to the left and 100 yards in rear of target.	
12	.....	Sighting shot. Struck 5 yards to the left and 100 yards in rear of target.	
14	.....	Sighting shot. Struck 3 feet to the left and 60 yards in rear of target.	
13	.....	First primer failed. Sighting shot. Missed the target.	
14	.....	Sighting shot. Struck in front and in line with center of target.	Gun mounted on Buffington steel field carriage No. 4, with old spiral-spring brakes. Cannon friction primers, model 1887.
13	.....	Sighting shot. Struck 30 feet in front and 4 feet to the right of target.	Fired at 3,000-yards target. Aimed at upper left edge of target. Scott's sight used; secured to trunnion by one screw, which permitted it to revolve, thus changing sight each time.
14	.....	Sighting shot. Struck 30 yards in rear and 5 yards to the left of target.	
13	.....	Sighting shot. Struck 70 yards in rear and 5 yards to the right of target.	
10	.....	Sighting shot. Struck target 4 feet below and 6 feet left of center.	
10	.....	Sighting shot. Struck 20 yards in front and 4 yards to the right of target.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test gun

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Wind allowance (points right).	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.				
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′		*Feet.*	
Sept. 11	1561		4 6		19 0 1 0 sand. 20 0	4 39	0	11	
Sept. 11	1562		4 6		19 0 1 0 sand. 20 0	4 39	½*	10	
Sept. 11	1563		4 6		18 15 1 1 sand. 20 0	4 39	½	9	
Sept. 11	1564		4 6		18 14 1 2 sand. 20 0	4 39	½	10	
Sept. 11	1565		4 6		18 14 1 2 sand. 20 0	4 39	½	10	
Sept. 11	1566		4 6		18 14 1 2 sand. 20 0	4 39	½	10	
Sept. 11	1567		4 6		19 0 1 0 sand. 20 0	4 39	½	10	
A. M. Sept. 12	1568		4 6		18 13 1 3 sand. 20 0	4 22	½	10	
Sept. 12	1569		4 6		18 15 1 1 sand. 20 0	4 22	0	11	
Sept. 12	1570		4 6		18 14 1 2 sand. 20 0	4 20	0	10	

Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.

Shell (banded), experimental, lot 326.

Four miles an hour.

*Left.

Arsenal, at Sandy Hook, N. J., September 11 and 12, 1891.

for endurance and accuracy.]

From center of target.				From center of impact.				Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Vertical		Horizontal.		Vertical.		Horizontal.			
Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.		
Ft.	*Ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*		
....	....	.....	.....	.....	.....	.....	.....	Sighting shot	
....	1	5	.....	0.5	.....	2.75	.....	.....	
....	4	2	.....	.....	2.5	.....	0.25	.....	
....	....	4	.....	1.5	.....	1.75	.....	.....	
....	1	.....	2	0.5	.....	.....	4.25	.....	
....	....	.....	.....	.....	.....	.....	.....	Sighting shot. Struck 100 yards in rear and to the left of target.	
....	....	.....	.....	.....	.....	.....	.....	Sighting shot. Struck 85 yards in rear and to the left of target.	
....	....	.....	.....	.....	.....	.....	.....	Sighting shot. Struck 25 yards in rear and to the left of target.	
....	....	.....	.....	.....	.....	.....	.....	Sighting shot. Struck 150 yards to the left of target.	
....	....	.....	.....	.....	.....	.....	.....	Sighting shot. Struck 150 yards in rear and 15 yards to the left of target.	

Gun mounted on Buffington steel field carriage No. 4, with old spiral-spring brakes.
Fired at 3,000-yards target. Aimed at the upper left-hand corner.
Cannon friction primers.
Scott's sight used; secured to trunnion by one large screw, which permitted it to revolve, thus changing sight each time.

	Feet.
Center of impact:	
Below	1.5
Right.....	2.25
Mean vertical deviation from center of impact.....	1.25
Mean horizontal deviation from center of impact	2.25
Mean deviation from center of impact...	2.57
Deviation of center of impact from line of fire.....	26.15

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test gun for

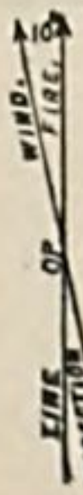
Date.	No. of fire.	Powder.		Projectile.		Elevation.	Wind allowance.		Recoil.
		Kind.	Weight.	Kind.	Weight.		Points right.	Points left.	
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′			*Feet.*
Sept. 12	1571		4 6		18 13 1 3 sand. 20 0	4 16	.....	.....	10
Sept. 12	1572		4 6		18 13 1 3 sand. 20 0	5 10	.....	.....	12
Sept. 12	1573		4 6		19 0 1 0 sand. 20 0	5 15	.....	⅛	10
Sept. 12	1574		4 6		18 14 1 2 sand. 20 0	5 20	¼	.....	10
Sept. 12	1575		4 6		18 15 1 1 sand. 20 0	5 25	¼	.....	11
Sept. 12	1576		4 6		19 0 1 1 sand. 20 0	5 30	1	.....	10
Sept. 12	1577		4 6		18 14 1 2 sand. 20 0	5 30	1	.....	10
Sept. 12	1578		4 6		19 1 15 sand. 20 0	5 30	1	.....	12
Sept. 12	1579		4 6		18 13 1 3 sand. 20 0	5 30	1	.....	11
Sept. 12	1580		4 6		18 15 1 1 sand. 20 0	5 30	1	.....	.....
P. M.									
Sept. 16	1581		4 6		18 15 1 1 sand. 20 0	3 56	.....	⅛	10
Sept. 16	1582		4 6		18 12 1 4 sand. 20 0	3 56	.....	⅛	10
Sept. 16	1583		4 6		18 15 1 1 sand. 20 0	3 56	.....	⅛	10

Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.

Shell (banded), experimental, lot 326.

Arsenal, at Sandy Hook, N. J., September 12 and 16, 1891.

endurance and accuracy.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Four miles an hour.	Sighting shot. Struck 150 yards in rear and 15 yards to the left.	Gun mounted on Buffington steel field carriage No. 4, with old spiral-spring brakes. Cannon friction primers, model 1887. Fired at 3,000-yards target. Aimed at upper left-hand corner. Scott's sight used; secured to trunnion by one screw, which permitted it to revolve, thus changing sight each time. Gun sighted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer. Firing conducted by the testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
	Sighting shot. Struck 100 yards in front of target and in line with center.	
	Sighting shot. Struck 80 yards in front of target and in line with center.	
	Sighting shot. Struck 75 yards in front of target and little to the right.	
	Sighting shot. Struck 15 yards in front of target; ricocheted through.	
	Sighting shot. Struck 15 yards in front of target.	
	Sighting shot. Struck target 4½ feet below and 14 feet to the right of bull's-eye.	
	Sighting shot. Strnck target 9 feet below and 17 feet to the right of bull's-eye.	
	Sighting shot. Struck target 1 foot below and 18 feet to the right of bull's-eye.	
	Sighting shot. Struck 3 feet to the right of target.	
Ten miles an hour.	Sighting shot. Strnck target 4 feet above and 8 feet to the left of bull's-eye.	
	Sighting shot. Struck the ground 75 yards in rear and 10 yards to the left.	
	Sighting shot. Struck the ground 125 yards in rear.	

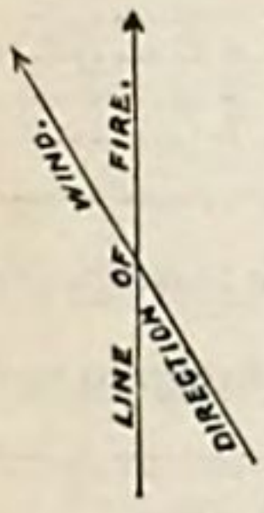
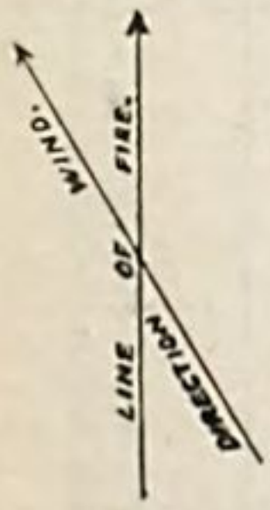
Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, experiments with Merriam fuse, to test

	No. of fire.	Powder.		Projectile.		No. of fuse.	Elevation.	Pressure per square inch of bore.	Recoil.
		Kind.	Weight.	Kind.	Weight.				
			Lbs. Oz.		*Lbs. Oz.*		° ′	*Pounds.*	*Feet.*
P.M ...	1584	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 10	Shell, lot 326.	18 15 1 1 sand. 20 0	68	5 00	No. 3, 35, 940	9
	1585		4 10		18 14 1 2 sand. 20 0	65	5 00	.....	10
	1586		4 10		18 13 1 3 sand. 20 0	73	5 00	.....	10
	1587		4 10		18 15 1 1 sand. 20 0	72	5 00	.....	10
	1588		4 10		18 14 1 2 sand. 20 0	70	5 00	.....	10
	1589		4 10		18 13 1 3 sand. 20 0	75	5 00	.....	10
	1590		4 10		18 14 1 2 sand. 20 0	71	5 00	.....	10
	1591		4 10		18 15 1 1 sand. 20 0	74	5 00	.....	10
	1592		4 10		18 15 1 1 sand. 20 0	76	5 00	.....	10

Watervliet Arsenal, at Sandy Hook, N. J., September 16, 1891.

fuse bases under pressure in excess of service pressure.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Ten miles an hour.	Base depressed about $\frac{1}{64}$ inch. Joint and pistons tight. Ball released.	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Cannon friction primers, model 1887. Bases of 10 per cent aluminium bronze. Fired from platform on fort wall to sea. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Fuse in housing placed in base of cartridge bag. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
	Blow-holes in casting. Gas penetrated into cavity, but small charge not ignited. Ball released.	
	Depression scarcely perceptible. Ball released.	
	Depression not perceptible. Housing beginning to show signs of upsetting. Ball released.	
	Fuse struck rock in falling from gun. Ball released. No depression of base.	
	Blow-holes in casting, but gas did not penetrate. No depression of base.	
	Ball released. No depression.....	
	Fired with no ball. No depression...	
	Blow-holes in base, and gas penetrated. Fired with no ball.	
Ten miles an hour.		
		

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test gun

	No. of fire.	Powder.		Projectile.		Including sand.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.		
			Pounds.		*Pounds.*	*Lbs. Oz.*	*Pounds.*
P. M.	1593	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5	Lot 249.	20	1 4	No. 3, 35, 940
	1594		5		20	1 4	----------
	1595		5		20	5	----------
	1596		5		20	2	----------
	1597		5		20	5	----------
	1598		5		20	1 0	----------
	1599		5		20	4	----------
	1600		5		20	2	----------
	1601		5		20	1 0	----------
	1602		5		20	Natural...	----------
	1603		5		20	1	----------
	1604		5		20	6	----------
	1605		5		20	Natural...	----------
	1606		5	Shell rebanded.	20	1	----------
	1607		5		20	2	----------
	1608		5		20	10	----------
	1609		5		20	13	----------
	1610		5		20	4	----------
	1611		5		20	6	----------
	1612		5		20	3	----------
	1613		5		20	5	----------
	1614		5		20	1	----------
	1615		5		20	10	----------
	1616		5		20	6	----------
	1617		5		20	7	----------
	1618		5		20	4	----------
	1619		5		20	3	----------
	1620		5		20	4	----------
	1621		5		20	3	----------
	1622		5		20	7	----------

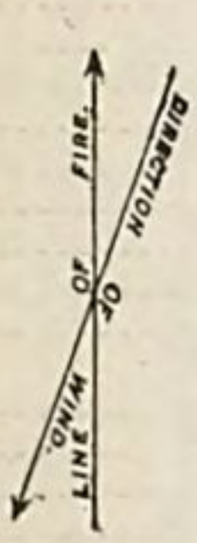
Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test gun

	No. of fire.	Powder.		Projectile.		Elevation.	Wind allowance.		Recoil.
		Kind.	Weight.	Kind.	Weight.		Points right.	Points left.	
			Lbs. Oz.		*Lbs. Oz.*	° ′			*Feet.*
P. M.	1623	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	4 6	Shell rebanded.	19 0 1 0 sand. 20 0	5 30	.....	½	10
	1624		4 6		19 0 1 0 sand. 20 0	5 30	½	.....	10
	1625		4 6	Shell, lot 326.	19 0 1 0 sand. 20 0	5 30	1½	.....	10
	1626		4 6		19 1 15 sand. 20 0	5 30	2½	.....	10
	1627		4 6		19 2 14 sand. 20 0	5 30	.....	½	10

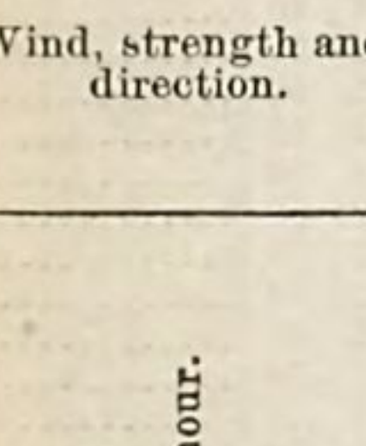
Watervliet Arsenal, at Sandy Hook, N. J., September 17, 1891.

for endurance and rapidity.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Six miles an hour. 	Three primers failed. Clevis of left brake broken. Vent reamed out.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on right wheel; old spiral spring brake on left wheel. Elevation, zero. Cannon friction primers, model 1887. Fired into field butt, section 1. Time occupied in firing eight rounds (1595 to 1602, inclusive), three minutes and forty-five seconds. Fired to sea. No sights used. Time occupied in firing twenty rounds (1603 to 1622, inclusive), eight minutes. No sights used. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.

Watervliet Arsenal, at Sandy Hook, N. J., September 17, 1891.

for accuracy and endurance.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Six miles an hour. 	Sighting shot. Struck the ground 100 yards in front and 25 yards to the left of target. Sighting shot. Struck the ground 100 yards in rear and 10 yards to the left of target. Sighting shot. Struck 100 yards in rear and little to the left of target. Sighting shot. Struck 40 yards in rear and little to the left of target. Frankford Arsenal front sight used. Sighting shot. Struck 80 yards in rear and little to the right of target.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on right wheel; old spiral-spring brake on left wheel. Cannon friction primers, model 1887. Fired at 3,000-yards target. Aimed at upper left-hand corner. Scott sight used; elevation with quadrant. Seat for Scott sight secured to trunnion by one large screw, which permitted it to revolve, thus changing sight each time. Firing conducted by the testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department; of board for testing rifled cannon.

Record of firing with 3.6-inch B. L. rifle (steel), No 1,

[Object of firing, to test

	No. of fire.	Powder.		Projectile.		Including—	Elevation.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
			Lbs.		*Lbs. Oz.*	*Ounces.*	° ′	*Pounds.*
	1628	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5	Shell rebanded.	19 3	*Powder.* 6	2 50	
	1629		5		19 3	6	2 50	
	1630		5		19 0	6	2 50	
	1631		5		19 3	6	2 50	
	1632		5		19 2	6	2 50	
	1633		5		18 15	6	2 50	
	1634		5		19 5	6	2 50	
	1635		5		19 5	6	2 50	
	1636		5		19 0	6	2 50	
	1637		5		19 3	6	2 50	
	1638		5		20 0	Natural	2 50	
	1639		5		20 0	Natural	2 50	
	1640		5		20 0	Natural	2 50	
	1641		5		20 0	Natural	2 50	
	1642		5		20 0	Natural	2 50	
	1643		5		20 0	Natural	2 50	No. 3, 36, 100
	1644		5		20 0	Natural	2 50	
	1645		5		20 0	Natural	2 50	
	1646		5		20 0	Natural	2 50	
	1647		5		20 0	Natural	2 50	
	1648		5		20 0	Natural	2 50	
	1649		5		20 0	Natural	2 50	
	1650		5		20 0	*Sand.* 2	2 50	
	1651		5		20 0	4	2 50	
	1652		5		20 0	4	2 50	
	1653		5		20 0	4	2 50	
	1654		5		20 0	Natural	2 50	
	1655		5		20 0	13	2 50	
	1656		5		20 0	14	2 50	
A. M	1657		5		20 0	Natural	2 50	No. 3, 38, 400
	1658		5		20 0	2	2 50	
	1659		5		20 0	10	2 50	
	1660		5		20 0	Natural	2 50	
	1661		5		20 0	Natural	2 50	
	1662		5		20 0	Natural	2 50	
	1663		5		20 0	13	2 50	
	1664		5		20 0	3	2 50	
	1665		5		20 0	1	2 50	
	1666		5		20 0	Natural	2 50	
	1667		5		20 0	Natural	2 50	
	1668		5		20 0	Natural	2 50	
	1669		5		20 0	Natural	2 50	
	1670		5		20 0	Natural	2 50	
	1671		5		20 0	Natural	2 50	
	1672		5		20 0	Natural	2 50	
	1673		5		20 0	4	2 50	
	1674		5		20 0	14	2 50	
	1675		5		20 0	Natural	2 50	
	1676		5		20 0	Natural	2 50	
	1677		5		20 0	Natural	2 50	
	1678		5	Shell, lot 326.	19 3	*Powder.* 6	2 50	
	1679		5		19 4	6	2 50	
	1680		5		19 2	6	2 50	
	1681		5		19 5	6	2 50	
	1682		5		19 8	6	2 50	
	1683		5		19 4	6	2 50	
	1684		5		19 2	6	2 50	
	1685		5		19 3	6	2 50	
	1686		5		19 2	6	2 50	
	1687		5		19 4	6	2 50	

Watervliet Arsenal, at Sandy Hook, N. J., September 19, 1891.

gun for endurance.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
10	Eight miles an hour.	Shell did not burst	
11		Shell burst	
13		Shell burst	
13		Shell burst	
14		Shell burst	
12		Shell did not burst	
12		Shell did not burst	
13		Shell burst	
14		Shell burst	
13		Shell burst	
15			
14			
13			
14			
14			
15			
14			
15			
15			
14			
14			
14			
14			
15			Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on right wheel; old spiral-spring brake on left wheel.
15			Fired to sea.
15		First primer failed	Fuse hole of lot 326, $\frac{1}{64}$-inch in diameter larger.
16			Copper cylinders of 32,000 pounds initial compression and tables of 1890.
14			Firing conducted by the testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
14			
15			
14			
15			
16		First primer failed	
13			
14			
15			
14			
14			
14			
15			
15			
14			
13			
15		First primer failed	
14			
15			
14			
15	Eight miles an hour.	Shell did not burst	
15		Shell did not burst	
15		Shell burst	
14		Shell did not burst	
14		Shell burst	
14		Shell did not burst	
15		Shell did not burst	
14		Shell burst	
10		Shell burst	
14		Shell did not burst	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, to test gun

	No. of fire.	Powder.		Projectile.		Elevation.	Wind allowance, (points left).	Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.				
			Lbs. Oz.		*Lbs. Oz.*	° ′		*Feet.*	
P. M....	1688	Du Pont's sphero-hexagonal U. F., lot 3; density, 1,700; granulation, 123.	4 6	Shell, lot 326.	18 14 1 2 sand. 20 0	5 25	.....	10	Six miles an hour.
	1689		4 6		18 15 1 1 sand. 20 0	5 25	.....	10	
	1690		4 6		18 14 1 2 sand. 20 0	5 25	½	10	
	1691		4 6		18 12 1 4 sand. 20 0	5 25	½	10	
	1692		4 6		19 1 15 sand. 20 0	5 25	½	10	
	1693		4 6		19 0 1 0 sand. 20 0	5 25	½	10	
	1694		4 6		18 15 1 1 sand. 20 0	5 25	½	10	
	1695		4 6		18 14 1 2 sand. 20 0	5 25	½	10	
	1696		4 6		18 13 1 3 sand. 20 0	5 25	½	10	
	1697		4 6		18 12 1 4 sand. 20 0	5 25	½	10	
	1698		4 6		18 14 1 2 sand. 20 0	5 25	½	10	
	1699		4 6		19 0 1 0 sand. 20 0	5 25	½	10	
	1700		4 6		18 13 1 3 sand. 20 0	5 25	½	10	
	1701		4 6		18 14 1 2 sand. 20 0	5 25	½	10	

Watervliet Arsenal, at Sandy Hook, N. J., September 21, 1891.

for accuracy and endurance.]

From center of target.				From center of impact.				Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Vertical.		Horizontal.		Vertical.		Horizontal.			
Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.		
Ft.	*Ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*		
....	....	.....	.....	.....	.....	.....	.....	Sighting shot. Struck target 17 feet to the right of center.	
....	....	.....	.....	.....	.....	.....	.....	Sighting shot. Struck the ground 20 feet in front, ricocheted through target 16 feet to the right of bull's-eye.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brake on right wheel; old spiral-spring brake on left wheel.
1	....	6	.....	3.6	.....	.7	.....	.....	Fired at 3,000-yards target. Aimed at the upper left-hand corner.
....	10	6	.....	.....	7.4	.7	.....	.....	Frankford Arsenal sights used.
....	1	5	.....	1.6	.....	.....	0.3	.....	Cannon friction primers, model 1887.
....	6	5.5	.....	.....	3.4	.2	.....	.....	Feet.
3	....	4	.....	5.6	.....	.....	1.3	.....	Center of impact: Below 2.6
....	....	.....	.....	.....	.....	.....	.....	Sighting shot. Struck the ground 100 yards in rear of target.	Right 5.3
6.5	....	6	.....	8.65	.....	4.05	.....	.....	Mean vertical deviation from center of impact..... 4.32
....	....	2	.....	2.15	.....	.....	.05	.....	Mean horizontal deviation from center of impact ..... .64
....	4	2	.....	.....	1.85	.05	.....	.....	Mean deviation from center of impact .. 4.36
....	4	5.5	.....	.....	1.85	3.55	.....	.....	Deviation of center of impact from line of fire, right.. 14.21
....	8	6	.....	.....	5.85	4.05	.....	.....	
....	5	.....	.....	.....	2.85	.....	1.95	.....	

Fired at 3,000-yards target. Aimed at upper left edge of target.

Cannon friction primers, model 1887.

Frankford Arsenal sights used.

Feet.

Center of impact:
Below 2.15
Right 1.95

Mean vertical deviation from center of impact..... 4.45

Mean horizontal deviation from center of impact..... 2.56

Mean deviation from center of impact.. 5.13

Deviation of center of impact from line of fire.....right.. 10.86

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to test gun

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Wind allowance (points left).	Recoil.	Wind, strength and direction.
			Lbs. Oz.		*Lbs. Oz.*	° ′		*Feet.*	
P. M....	1702	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	4 6	Shell, lot 326.	19 0 1 0 sand. 20 0	5 25	½	10	Six miles an hour.
	1703		4 6		18 12 1 4 sand. 20 0	5 25	½	10	
	1704		4 6		18 13 1 3 sand. 20 0	5 25	½	10	
	1705		4 6		19 1 15 sand. 20 0	5 25	½	10	

Arsenal, at Sandy Hook, N. J., September 21, 1891—Continued.

for accuracy and endurance.]

From center of target.				From center of impact.				Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Vertical.		Horizontal.		Vertical.		Horizontal.			
Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.		
Ft.	*Ft.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*		
....	2	3	.....	15	.....	1.05	.....	.....	Gun sighted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer. Firing conducted by the testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
....	12	.....	.....	.....	9.85	.....	1.95	.....	
....	....	.....	.....	2.15	.....	.....	1.95	.....	
7	....	.....	5	9.15	.....	.....	6.95	.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to

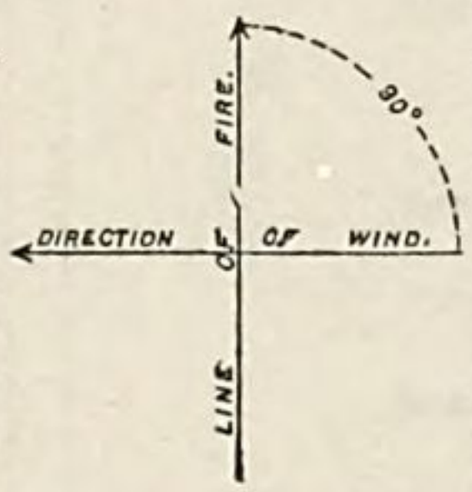
Date.	No. of fire.	Powder.		Projectile.		No. of fuse.	Elevation.	Instrumental velocity, 125 feet from muzzle.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Lbs. Oz.*		° ′	*Feet.*
Sept. 25	1706	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5 0	Shell, rebanded.	19 3 13 sand. 20 0	.....	5 00	.....
Sept. 25	1707		5 0		19 2 14 sand. 20 0	.....	2 30	.....
Sept. 25	1708		5 0		19 0 1 0 sand. 20 0	.....	3 30	.....
Sept. 25	1709		5 0		19 2 14 sand. 20 0	.....	4 00	.....
Sept. 25	1710		5 0		19 2 14 sand. 20 0	.....	4 00	.....
Sept. 25	1711		5 0		19 3 13 sand. 20 0	.....	4 00	.....
Sept. 25	1712		5 0		19 1 15 sand. 20 0	.....	4 00	.....
Sept. 25	1713		5 0		19 2 14 sand. 20 0	.....	4 00	.....

[Object of firing,

P. M.								
Sept. 28	1714	Laflin & Rand's I. K., Sept. lot 7; density, 1.710; granulation, 2,360.	4 12	Shell, lot 326.	18 15 1 1 sand. 20 0	.....	.....	.....
Sept. 28	1715		4 12		18 12 1 4 sand. 20 0	.....	.....	{ 1,527 1,544 }
Sept. 28	1716		4 12		18 14 1 2 sand. 20 0	.....	.....	{ 1,538 1,547 }
Sept. 28	1717		4 10		18 14 1 2 sand. 20 0	.....	.....	{ 1,516 1,520 }
Sept. 28	1718	Du Pont's grain V. V.; density, 1.722; Laflin & Rand's I. K., granulation, 3,176. Received Sept. 26, 1891;	4 11		18 14 1 2 sand. 20 0	.....	.....	{ 1,530 1,537 }

Arsenal, at Sandy Hook, N. J., September 25 and 28, 1891.

test gun for endurance.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*			
.....	12	Eight miles an hour. 	.....	Gun mounted on Buffington steel field carriage No. 4. Old spiral-spring brakes. Fired from fort wall to sea. Cannon friction primers, model 1887. Gun star-gauged after round 1713, September 28, 1891, by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by the testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. W. W. Gibson, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
.....	13		.....	
.....	14		.....	
.....	15		.....	
.....	15		.....	
.....	15		.....	
.....	14		.....	
.....	14		.....	

to prove powder.]

.....	15	Twelve miles an hour.	Warming charge	
No. 3, 36, 488	15		.....	Gun mounted on Buffington steel field carriage No. 4, with bow-spring brake on right wheel; old spiral-spring brake on left wheel. Cannon friction primers, model 1887. Fired into field butt, section 2. Copper cylinders of 32,000 pounds initial compression and tables of 1890.
No. 3, 39, 900	16		.....	
No. 3, 34, 446	16		.....	
No. 3, 35, 900	16		.....	

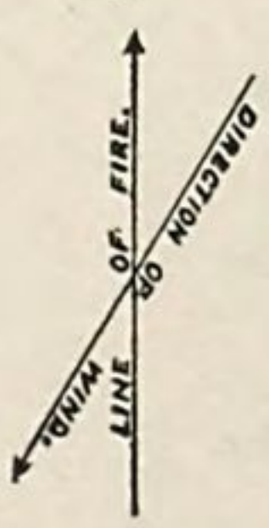
Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		No. of fuse.	Elevation.	Instrumental velocity, 125 feet from muzzle.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Lbs. Oz.*		° ′	*Feet.*
Sept. 28	1719	Du Pont's grain V. W.; density, 1.734; granulation, 3,700. Received Sept. 26, 1891.	4 10	Shell, lot 326.	18 14 1 2 sand. 20 0	.....	.....	1,480 to 1,483
Sept. 28	1720		4 12		19 1 15 sand. 20 0	.....	.....	1,500 to 1,501
Sept. 28	1721		4 12		18 12 1 4 sand. 20 0	.....	.....	1,503 to 1,506
Sept. 28	1722		4 12		18 15 1 1 sand. 20 0	.....	.....	1,506 to 1,512
Sept. 28	1723		4 12		18 14 1 2 sand. 20 0	.....	.....	1,507 to 1,507
Sept. 28	1724		4 12		18 15 1 1 sand 20 0	.....	.....	1,507 to 1,509
A. M. Sept. 29	1725	Laflin & Rand's, lot 7.	4 12		18 12 1 4 sand. 20 0	.....	.....	.....
Sept. 29	1726	Du Pont's grain V. X.; density, 1.746; granulation, 3,380 Received Sept. 26, 1891.	4 12		18 14 1 2 sand. 20 0	.....	.....	1,503 to 1,509
Sept. 29	1727		4 12		18 15 1 1 sand. 20 0	.....	.....	1,502 to 1,505
Sept. 29	1728		4 12		18 14 1 2 sand. 20 0	.....	.....	1,502 to 1,505
Sept. 29	1729		4 12		18 15 1 1 sand. 20 0	.....	.....	1,504 to 1,506
Sept. 29	1730		4 12		18 14 1 2 sand. 20 0	.....	.....	1,500 to 1,502
								50+$\frac{15}{2}$°

Arsenal, at Sandy Hook, N. J., September 28 and 29, 1891.

to prove powder.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*			
No. 3, 32, 180	16	Twelve miles an hour.	.....	Gun mounted on Buffington steel field carriage No. 4, with bow-spring brake on right wheel; old spiral-spring brake on left wheel. Cannon friction primers, model 1887. Fired into field butt, section 2. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
No. 3, 32, 520	16		.....	
No. 3, 33, 646	16		.....	
No. 3, 33, 400	15		Lanyard broke	
No. 3, 32, 154	15		.....	
No. 3, 33, 516	16		.....	
.....	15		Warming charge.....	
No. 3, 33, 755	16	Twelve miles an hour. 	.....	
No. 3, 34, 666	15		.....	
No. 3, 33, 946	16		.....	
No. 3, 34, 100	15		.....	
No. 3, 36, 100	16		.....	

Record of firing with 3.6-inch B. L. rifle (steel), No 1, Watervliet Arsenal,

[Object of firing, experiments

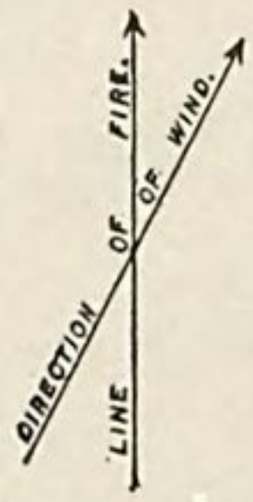
Date.	No. of fire.	Powder.		Projectile.		No. of fuse.	Elevation.	Instrumental velocity, 125 feet from muzzle.
		Kind.	Weight.	Kind.	Weight.			
A. M.			*Lbs. Oz.*		*Lbs. Oz.*		° ′	*Feet.*
Sept. 29	1731	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	1 8	Shell, lot 326, altered to receive fuse.	19 5 shell and fuse. 6 rifle powder, bursting charge. 19 11	73	30	.....
Sept. 29	1732		1 8		19 2 shell and fuse. 6 rifle powder, bursting charge. 19 8	70	3 30	.....
Sept. 29	1733		4 12		19 0 shell and fuse. 6 rifle powder, bursting charge. 19 6	65	3 30	.....

[Object of firing, test

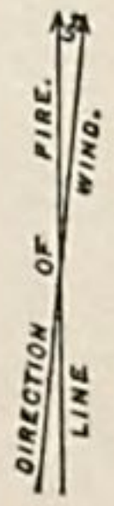
A. M.								
Oct. 24	1734	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5 0	Received from Watervliet Arsenal October 21, 1891.	19 1 6 powder. 19 7	.....	1 30	.....
Oct. 24	1735		5 0		19 3 6 powder. 19 9	.....	1 30	.....
Oct. 24	1736		5 0		19 0 6 powder. 19 6	.....	1 30	.....
Oct. 24	1737		5 0		19 1 6 powder. 19 7	.....	1 30	.....
Oct. 24	1738		5 0		19 0 6 powder. 19 6	.....	1 30	.....
P. M.								
Oct. 24	1739		5 0		18 15 13 powder. 19 12	.....	1 30	.....
Oct. 24	1740		5 0		19 0 13 powder. 19 13	.....	1 30	.....
Oct. 24	1741	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5 0	Shell, lot 336. Received from Watervliet Arsenal October 21, 1891.	19 1 13 powder. 19 14	.....	1 30	.....
Oct. 24	1742		5 0		19 0 13 powder. 19 13	.....	1 30	.....
Oct. 24	1743		5 0		19 2 13 powder. 19 15	.....	1 30	.....

at Sandy Hook, N. J., September 29 and October 24, 1891.

with Merriam base percussion fuse.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*			
No. 3, less than 9,000.	8	Twenty miles an hour.	Shell burst on striking ground 300 yards from gun. Copper cylinders of 9,000 pounds initial compression and tables of 1890.	Gun mounted on Buffington steel field carriage (light) No. 17. Bow-spring brake on right wheel; old spiral-spring brake on left wheel. Cannon friction primers, model 1887. Fired down the beach. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
No. 3, 6, 800	8		Shell burst on striking ground 400 yards from gun. Uncompressed copper cylinders and tables of 1890.	
No. 3, 33, 120	10		Fuse inserted in shell with difficulty; shell burst on striking ground 1 mile from gun. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	

of 3.6-inch projectiles.]

.....	15	Twenty miles an hour.	Shell struck water. Did not burst.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Brake on right wheel used in previous firings. Cannon friction primers, model 1887. Fired to sea. Base plugs used without washers. Seat for Bode quadrant secured to right trunnion before this firing. Firing conducted by Lt. C. B. Wheeler, Ordnance Department, assistant proof officer.
.....	15		Shell struck water. Did not burst.	
.....	16		Gun hung fire. Shell struck water. Did not burst.	
.....	15		Shell struck water. Did not burst.	
.....	15		First primer failed. Shell struck water. Did not burst.	
.....	16		Gun hung fire. Shell struck water. Did not burst.	
.....	15		Gun hung fire. Shell struck water. Did not burst.	
.....	16		Gun hung fire. Shell struck water. Did not burst.	
.....	16		Shell struck water. Did not burst.	
.....	17		Gun hung fire. Shell struck water. Did not burst.	

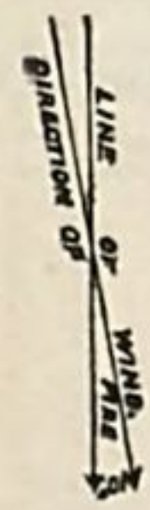
Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing, test of Bodo

Date.	No. of fire.	Powder.		Projectile.		Elevation.	No. of fuse.	Wind allowance (points left).	Recoil.
		Kind.	Weight.	Kind.	Weight.				
			Lbs. Oz.		*Lbs. Oz.*	° ′			*Feet.*
P. M. Oct. 26	1744	Laflin & Rand's I. K., lot 7; density, 1,710; granulation, 2,360.	5 0	Shell, lot 326.	18 12 6 powder. 19 2	1 7½	.....	1½	14
Oct. 26	1745		5 0		18 12 6 powder. 19 2	1 7½	.....	1½	14
Oct. 26	1746		5 0		18 15 6 powder. 19 5	1 7½	.....	1½	15
Oct. 26	1747		5 0		18 13 6 powder. 19 3	1 7½	.....	1½	14
Oct. 26	1748		5 0		19 0 6 powder. 19 6	1 7½	.....	1½	14
Oct. 26	1749		5 0		19 0 6 powder. 19 6	1 11	.....	1½	15
Oct. 26	1750		5 0		18 14 6 powder. 19 4	1 11	.....	1½	15
Oct. 26	1751		5 0		18 14 6 powder. 19 4	1 11	.....	1½	14
Oct. 26	1752		5 0		19 0 6 powder. 19 6	1 11	.....	1½	15

Watervliet Arsenal, at Sandy Hook, N. J., October 26, 1891.

quadrant and shell.

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Ten miles an hour. 	Shell burst in gun	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Frankford Arsenal sight and Bode quadrant used. Fired at 1,000-yards target. Aimed at the upper right-hand corner. Rounds 1749 to 1752, inclusive; inside of shell coated with paraffine put into shell hot. Base plug used with leather washers in rounds 1744 to 1748, inclusive. Vertical deviation from center of impact of rounds 1749 to 1751, inclusive = 156 feet. Vertical deviation from center of impact of rounds 1745 and 1747, inclusive = 0. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
	Struck target 6 feet below and 18 feet right of center.	
	Shell burst in gun	
	Struck target 6 feet below and 13 feet right of center.	
	Shell burst in gun	
	Struck target 1½ feet below and 14 feet right of center.	
	Gun hung fire. Struck target 4½ feet below and 16 feet right of center.	
	Struck target 5½ feet below and 10 feet right of center.	
	Shell burst in gun	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to

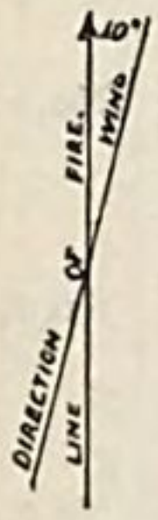
Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	No. of fuse.	Wind allowance (points left).	Recoil.
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′			*Feet.*
Oct. 29	1753	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5 0	Shell, lot 326, altered to receive Merriam base percussion fuse.	19 4 including fuse. 10 rifle powder, bursting charge. 19 14	.....	77	.....	14
Oct. 29	1754		5 0		19 2 including fuse. 10 rifle powder, bursting charge. 19 12	.....	78	.....	15
Oct. 29	1755		5 0		19 4 including fuse. 10 rifle powder, bursting charge. 19 14	.....	74	.....	15
Oct. 29	1756		5 0		19 3 including fuse. 10 rifle powder, bursting charge. 19 13	.....	75	.....	14
Oct. 29	1757		5 0		19 2 including fuse. 10 rifle powder, bursting charge. 19 12	.....	79	.....	15

[Object of firing, to

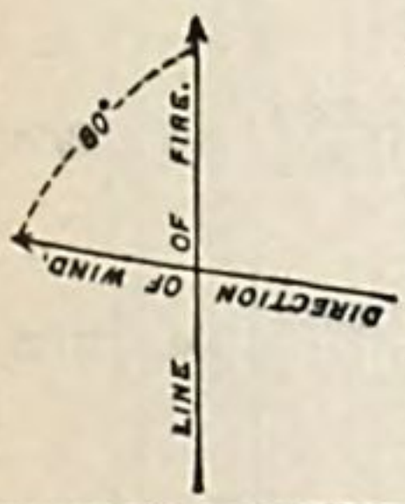
A. M.									
Oct. 31	1758	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5 0	Shell, lot 326.	18 10 natural weight.....	1 00	.....	.....	14
Oct. 31	1759		5 0		19 0 natural weight.....	1 00	.....	.....	14
Oct. 31	1760		5 0		18 15 natural weight.....	1 00	.....	.....	14
Oct. 31	1761		5 0		18 12 natural weight.....	1 00	.....	.....	14
Oct. 31	1762		5 0		18 13 natural weight.....	1 00	.....	.....	15
Oct. 31	1763		5 0		18 12 natural weight.....	1 00	.....	.....	15
Oct. 31	1764		5 0		18 14 natural weight.....	1 00	.....	.....	14
Oct. 31	1765		5 0		18 15 natural weight.....	1 00	.....	.....	15
Oct. 31	1766		5 0		19 0 natural weight.....	1 00	.....	.....	15
Oct. 31	1767		5 0		19 0 natural weight.....	1 00	.....	.....	15

Arsenal, at Sandy Hook, N. J., October 29 and 31, 1891.

test Merriam fuses.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Sixteen miles an hour. 	Fuse with automatic delay. Distance of 1 inch screen from 2-inch screen, 25 feet. Gun hung fire. Shell passed through both screens, making a clean hole, and burst after passing through second one. Fuse with automatic delay. Distance of 1-inch screen from 2-inch screen, 75 feet. Shell burst in gun. Fuse without delay. Fired to burst at 2-inch screen. Burst at screen. Fuse without delay. Fired to burst at 2-inch screen. Burst at screen. Fuse with automatic delay. Shell passed through 2-inch screen and burst at 1-inch screen 75 feet beyond.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Base of shell turned down $\frac{1}{16}$ inch for a distance of $1\frac{3}{8}$ inches from base, which included $\frac{1}{8}$ inch of the rotating band. Copper bonnet slightly lipped at edges forced on rear end of projectile, so that lips engaged on copper band. Fired at screen 2 inches thick, 6 feet high, and 4 feet wide, 150 feet from gun. Aimed at center. Two screens used. The first one to burst shell and the second to record place of bursting. Second screen 8 feet high, 6 feet wide, by 1 inch thick. Frankford Arsenal sight used. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.

test 3.6-inch projectile.]

Nine miles an hour. 	Shell struck water without breaking. Shell struck water without breaking. Shell struck water without breaking. Shell struck water without breaking. Shell struck water without breaking. Shell struck water without breaking. Shell struck water without breaking. Shell struck water without breaking. Shell struck water without breaking. Shell struck water without breaking.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired to sea. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.

Record of firing with 3.6-inch B. L. rifle (steel), No. 1,

[Object of firing

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Feet.*	*Pounds.*
P. M	1768	Laflin & Rand's I.K., lot 7; density, 1.710; granulation, 2,360.	4 12	Shell, lot 326.	19 0 1 0 sand. 20 0	1 00	.....	.....
	1769	Du Pont's grain powder V. V., lot 2; granulation, 2,585; density, 1.725.	4 8		18 12 1 4 sand. 20 0	0 00	1,510 1,512	No. 3, 32, 890
	1770		4 12		18 12 1 4 sand. 20 0	0 05	1,560 1,560	No. 3, 35, 855
	1771		4 12		19 0 1 0 sand. 20 0	0 05	1,564 1,560	No. 3 36 200
	1772		4 12		19 0 1 0 sand. 20 0	0 05	1,560 1,560	No. 3, 35, 666
	1773		4 12		19 0 1 0 sand. 20 0	0 05	1,563 1,555	No 3, 36, 200
	1774	Du Pont's grain powder V. V., lot 3; density, 1.725; granulation, 2,720.	4 12		18 13 1 3 sand. 20 0	0 05	1,566 1,558	No. 3 35 940
	1775		4 12		18 11 1 5 sand. 20 0	0 05	1,554 1,548	No. 3, 33, 400
	1776		4 12		18 14 1 2 sand. 20 0	0 05	50+½ 1,552 1,543	No. 3, 33, 800
	1777		4 12		18 9 1 7 sand. 20 0	0 05	1,558 1,548	No. 3, 33, 945
	1778		4 12		18 11 1 5 sand. 20 0	0 05	1,552 1,545	No. 3, 35, 500
	1779		4 12		18 11 1 5 sand. 20 0	0 05	1,553 1,546 50+½	No. 3, 34, 555

Watervliet Arsenal, at Sandy Hook, N. J., November 2, 1891.

to prove powder.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
14	Twelve miles an hour. LINE OF FIRE. DIRECTION OF WIND.	Warming charge; fired to sea.....	
14		.....	
15		.....	
14		Gun hung fire	
17		.....	
16		.....	Gun mounted on Buffington steel field-carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired into field butt, section 1. Copper cylinders of 32,000 pounds initial compression and tables of 1890. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer. Impressions of powder and shot chamber and beginning of rifling taken November 10, 1891.
16		Gun hung fire	
16		.....	
17	Twelve miles an hour. LINE OF FIRE. DIRECTION OF WIND.	.....	
17		.....	
17		.....	
18		Right wheel would not turn after this round. Wheel taken off; axle-arm and box found to be badly scratched and scored. Box dry, but contained a quantity of fine iron scorings. Axles were greased.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, experiments

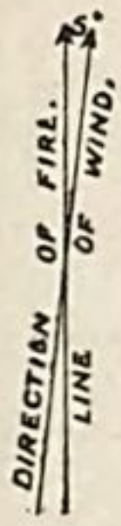
Date.	No. of fire.	Powder.		Projectile.		Elevation.	No. of fuse.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs.* *Oz.*		*Lbs.* *Oz.*	° ′		*Pounds.*
Nov. 11	1780	Laflin & Rand's I. K., lot 7; density, 1.710, granulation, 2,360.	5 0	Shell, lot 336, altered for fuse.	18 4 shell. 1 4 fuse. 10 powder, bursting charge. 20 2	.....	80	.....
Nov. 11	1781		5 0		18 4 shell. 1 3 fuse. 10 powder, bursting charge. 20 1	.....	81	.....

[Object of firing, to observe effect

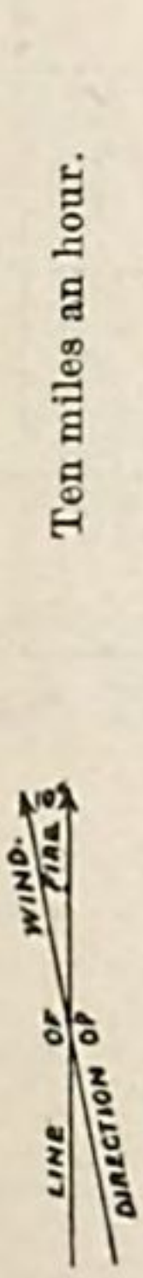
P. M.								
Nov. 12	1782	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5 0	Shell, lot 326.	19 1 15 sand. 20 0	.....	.....	.....
Nov. 12	1783		5 0		18 13 1 3 sand. 20 0	.....	.....	.....
Nov. 12	1784		5 0		18 15 1 1 sand. 20 0	.....	.....	.....
Nov. 12	1785		5 0		19 1 15 sand. 20 0	.....	.....	.....
Nov. 12	1786		5 0		19 0 1 0 sand. 20 0	.....	.....	.....
Nov. 12	1787		5 0		18 14 1 2 sand. 20 0	.....	.....	.....
Nov. 12	1788		5 0		19 0 1 0 sand. 20 0	.....	.....	.....
Nov. 12	1789		5 0		18 15 1 1 sand. 20 0	.....	.....	.....
Nov. 12	1790		5 0		18 13 1 3 sand. 20 0	.....	.....	.....
Nov. 12	1791		5 0		19 0 1 0 sand. 20 0	.....	.....	.....

Arsenal, at Sandy Hook, N. J., November 11 and 12, 1891.

with Merriam fuse.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragment s, etc., and metrological data.	General remarks.
Feet.			
33	Six miles an hour. 	First screen 6 feet high, 4 feet wide, and 2 inches thick, 150 feet from gun; second screen, 8 feet high, 6 feet wide, and 1 inch thick, 75 feet from first screen. First primer failed. Shell struck in water about 500 yards beyond second screen and burst.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fuse with automatic delay. Fired at screens.
17		First screen 6 feet high, 4 feet wide, and 3 inches thick, 150 feet from gun; second screen, 8 feet high, 6 feet wide, and 1 inch thick, 75 feet from first screen. Shell burst between first and second screens.	Impressions taken of the shot and powder chamber before this firing showed deep scorings at the beginning of the rifling and along the top of the powder chamber forward of the vent. Scorings beginning immediately at the vent where their depth is considerable, and extending forward to the end of the powder chamber, where their depth is less, bear much the appearance of a crack in the metal of the tube. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.

on score in top of powder chamber.]

14	Ten miles an hour. 	.....	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired to sea. After round 1791 gun cleaned out and powder chamber examined. No appreciable enlargement of score in front of vent could be noticed. The development of small scores in top of powder chamber starting to rear from vent observed.
15		.....	
14		.....	
14		.....	
14		.....	
15		.....	
15		.....	
14		.....	
15		.....	
15		.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to observe effect

Date.	No. of fire.	Powder.		Projectile.		Elevation.	No. of fuse.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′		*Pounds.*
Nov. 13	1792	Hazard powder Co., "Hazard F. G.," lot 7; density, 1.710; granulation, 2,360.	5 0	Shell, lot 326.	18 14 1 2 sand. 20 0	1 00	.....	.....
Nov. 13	1793		5 0		18 1 1 15 sand. 20 0	1 00	.....	.....
Nov. 13	1794		5 0		18 13 1 3 sand. 20 0	1 00	.....	.....
Nov. 13	1795		5 0		18 13 1 3 sand. 20 0	1 00	.....	.....
Nov. 13	1796		5 0		18 14 1 2 sand. 20 0	1 00	.....	.....
Nov. 13	1797		5 0		18 13 1 3 sand. 20 0	1 00	.....	No. 8, 32,033
Nov. 13	1798		5 0		18 1 1 15 sand. 20 0	1 00	.....	.....
Nov. 13	1799		5 0		18 1 1 15 sand. 20 0	1 00	.....	.....
Nov. 13	1800	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5 0		18 11 1 5 sand. 20 0	1 00	.....	.....
Nov. 13	1801		5 0		18 12 1 4 sand. 20 0	1 00	.....	.....

Arsenal, at Sandy Hook, N. J., November 13, 1891.

on score in top of powder chamber.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
12	Four miles an hour. Line of fire, direction of wind.	.....	
12		.....	
13		.....	
13		.....	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired to sea. After round 1801 gun cleaned out and impression made of powder chamber. Enlargement of score in front of vent quite noticeable, and scoring at base of rifling much more marked. Small score in top of powder chamber in rear of vent noticeable. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
14		.....	
13		Copper cylinder of 32,000 pounds initial compression and tables of 1890.	
15		Gun hung fire	
15		.....	
15		First primer failed.....	
14		.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, test

Date.	No. of fire.	Powder.		Projectile.		Elevation.	No. of fuse.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′		*Pounds.*
Nov. 24	1802	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 12	Shell, lot 336, altered for fuse.	18 5 shell. 10 rifle powder, bursting charge. 1 4 fuse. 20 3	.....	82	No. 8, 32,400
Nov. 24	1803		4 12		18 6 shell. 10 rifle powder, bursting charge. 1 4 fuse. 20 4	.....	83	No. 8, 33,836
Nov. 24	1804		4 12		18 4 shell. 10 rifle powder, bursting charge. 1 4 fuse. 20 2	.....	84	No. 8, 32,883
Nov. 24	1805		4 12		18 2 shell. 10 rifle powder, bursting charge. 1 4 fuse. 20 0	.....	85	No. 8, 32,800

[Object of firing, to observe effect

P. M.								
Nov. 24	1806	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5 0	Shell rebanded.	19 13 3 sand. 20 0	.....	.....	.....
Nov. 24	1807		5 0		19 13 3 sand. 20 0	.....	.....	.....
Nov. 24	1808		5 0		19 13 3 sand. 20 0	.....	.....	.....
Nov. 24	1809		5 0		19 13 3 sand. 20 0	.....	.....	.....
Nov. 24	1810		5 0		19 14 2 sand. 20 0	.....	.....	.....
Nov. 24	1811		5 0		19 13 3 sand. 20 0	.....	.....	.....
Nov. 24	1812		5 0		19 14 2 sand. 20 0	.....	.....	.....

Arsenal, at Sandy Hook, N. J., November 24, 1891.

of Merriam fuse.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
[*Feet.* 12	From rear, 35° right, 20 miles an hour.	To test automatic delay in thick target. Butt not boarded up behind and sand at natural slope. Shell burst in box. Smoke of burst seen behind box.	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes.
13		To test automatic delay in thick target. Back of box boarded up and filled with sand. Shell burst in box. Explosion of shell knocked out and broke all rear boards. Marks of explosion found on fragments of boards. Fragments of shell struck water about 100 yards beyond.	Fired into box filled with sand, size 4 by 4 feet and 4 feet high, about 65 feet from gun. Cannon friction primers, model 1887.
14		To test automatic delay in thin target. Screen 40 feet in front of gun and 25 feet from box. Shell passed through screen and burst after entering box. Powder marks of explosion seen on inside of front boards.	Copper cylinders of 32,000 pounds initial compression and tables of 1890. Fired at screen, 6 feet high, 4 feet wide, and 3 inches thick, placed in front of box. Cannon friction primers, model 1887.
14		To determine quickest action possible. Automatic delay cut out. Screen 35 feet in front of gun and 30 feet from box. Shell passed through and burst at screen. Fragments struck box and also passed beyond into water.	Pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.

on score in top of powder chamber.]

15	From rear, 35° right, 20 miles an hour.	.....	
14		.....	
15		.....	
15		.....	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired into field butt.
15		.....	
14		.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to observe effect

Date.	No. of fire.	Powder.		Projectile.		Elevation.	No. of fuse.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′		*Pounds.*
Nov. 24	1813	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5 0	Shell rebanded.	19 13 3 sand. 20 0	.....	.....	.....
Nov. 24	1814		5 0		19 13 3 sand. 20 0	.....	.....	.....
Nov. 24	1815		5 0		20 0	.....	.....	No. 8, 34,683
Nov. 24	1816		5 0		19 11 5 sand. 20 0	.....	.....	.....
Nov. 24	1817		5 0		19 14 2 sand. 20 0	.....	.....	.....
Nov. 24	1818		5 0		19 1 15 sand. 20 0	.....	.....	.....
Nov. 24	1819		5 0		19 12 4 sand. 20 0	.....	.....	.....
Nov. 24	1820		5 0		19 12 4 sand. 20 0	.....	.....	.....
Nov. 24	1821		5 0		19 12 4 sand. 20 0	.....	.....	.....
Nov. 24	1822		5 0		19 12 4 sand. 20 0	.....	.....	.....
Nov. 24	1823		5 0		19 3 13 sand. 20 0	.....	.....	.....
Nov. 24	1824		5 0		19 13 3 sand. 20 0	.....	.....	.....
Nov. 24	1825		5 0		20 0	.....	.....	No. 8, 36,800

Arsenal, at Sandy Hook, N. J., November 24, 1891—Continued.

on score in top of powder chamber.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
15	From rear, 35° right, 20 miles an hour.	----------	
15		----------	
15		Copper cylinder of 32,000 pounds initial compression and tables of 1890.	
15		----------	
14		----------	
15		----------	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired into field butt.
15		----------	Gun washed out and examined and impressions taken after round 1815. No marked difference in erosions noted from these impressions.
15		----------	Gun washed out and examined and impressions taken after round 1825. No marked difference in erosions noticed from these impressions.
15		----------	
16		----------	
15		----------	
15		----------	
15		Copper cylinders of 32,000 pounds initial compression and tables of 1890.	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to obtain

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Wind, strength and direction.	Range.
		Kind.	Weight.	Kind.	Weight.			
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′		*Yards.*
Nov. 25	1826	Du Pont's sphero-hexagonal U. F., lot 3; density, 1.700; granulation, 123.	4 6	Shell, lot 326.	19 0 1 0 sand. 20 0	1 00	From rear 10° right, 8 miles an hour.	905
Nov. 25	1827		4 6		19 0 1 0 sand. 20 0	1 00		950
Nov. 25	1828		4 6		18 13 1 3 sand. 20 0	1 00		944
Nov. 25	1829		4 6		18 15 1 1 sand. 20 0	1 00		949
Nov. 25	1830		4 6		19 2 14 sand. 20 0	2 00		1551
Nov. 25	1831		4 6		19 2 14 sand. 20 0	2 00		1843
Nov. 25	1832		4 6		18 3 1 13 sand. 20 0	2 00		1518
Nov. 25	1833		4 6		18 15 1 1 sand. 20 0	2 00		1519

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to observe effect of firing

Date.	No. of fire.	Powder.		Projectile.		Including sand.	No. on base.	Elevation.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.				
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Lbs. Oz.*		° ′	*Pounds.*
Nov. 30	1834	Laflin & Rand's L. K., lot 7; density, 1.710; granulation, 2,360.	5 0	Shell, lot 326.	20 0	1 1	.....	.....	No. 8, 32, 820
Nov. 30	1835		5 0		20 0	1 1	.....	.....	.....
Nov. 30	1836		5 0		20 0	1 3	.....	.....	.....
Nov. 30	1837		5 0		20 0	1 2	.....	.....	.....
Nov. 30	1838		5 0		20 0	1 0	.....	.....	.....
Nov. 30	1839		5 0		20 0	1 2	.....	.....	.....
Nov. 30	1840		5 0		20 0	1 0	.....	.....	.....
Nov. 30	1841		5 0		20 0	1 1	.....	.....	.....
Nov. 30	1842		5 0		20 0	1 2	.....	.....	.....
Nov. 30	1843		5 0		20 0	1 2	.....	.....	.....
Nov. 30	1844		5 0		20 0	1 2	.....	.....	.....
Nov. 30	1845		5 0		20 0	1 2	.....	.....	.....
Nov. 30	1846		5 0		20 0	1 0	.....	.....	.....
Nov. 30	1847		5 0		20 0	1 2	.....	.....	.....
Nov. 30	1848		5 0		20 0	1 1	.....	.....	.....
Nov. 30	1849		5 0		20 0	1 2	.....	.....	.....
Nov. 30	1850		5 0		20 0	14	.....	.....	.....
Nov. 30	1851		5 0		20 0	1 3	.....	.....	.....
Nov. 30	1852		5 0		20 0	1 0	.....	.....	.....
Nov. 30	1853		5 0		20 0	1 1	.....	.....	.....

Arsenal, at Sandy Hook, N. J., November 25, 1891.

range with Bode quadrant.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired down the beach. Bode quadrant used. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
Gun hung fire	
.....	
.....	
.....	
Undoubtedly a mistake; first strike not found....	
.....	
.....	

Arsenal, at Sandy Hook, N. J., November 30, 1891.

on score in top of powder chamber.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
17	From rear 10° right, 10 miles an hour.	Copper cylinders of 32,000 pounds initial compression and tables of 1890.	
18		.....	
17		.....	
20		Right brake jumped off wheel in recoiling.	
17		.....	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired to sea. After this firing gun washed out and examined and impressions taken. Marked increase in depth of erosions at slope of powder chamber and at beginning of rifling. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
17		.....	
17		.....	
16		.....	
16		.....	
17		Right brake jumped off wheel in recoiling.	
16		.....	
17		.....	
17		Right brake jumped off wheel in recoiling.	
16		.....	
17		.....	
16		Gun hung fire	
17		.....	
18		.....	
16		.....	
18		.....	

Record of firing with 3.6-inch B. L. rifle (steel), No. 1, Watervliet

[Object of firing, to observe effect of firing

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Including sand.	No. on base.	Elevation.	Pressure per square inch of bore.
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Lbs. Oz.*		° ′	*Pounds.*
Dec. 1	1854	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	5 0	Shell rebanded.	20 0	1 0	.....	1 00	No. 8, 32, 580
Dec. 1	1855		5 0		20 0	1 15	.....	1 00	.....
Dec. 1	1856		5 0		20 0	3	.....	1 00	.....
Dec. 1	1857		5 0		20 0	3	.....	1 00	.....
Dec. 1	1858		5 0		20 0	2	.....	1 00	.....
Dec. 1	1859		5 0		20 0	3	.....	1 00	.....
Dec. 1	1860		5 0		20 0	2	.....	1 00	.....
Dec. 1	1861		5 0		20 0	2	.....	1 00	.....
Dec. 1	1862		5 0		20 0	3	.....	1 00	.....
Dec. 1	1863		5 0		20 0	1	.....	1 00	.....
Dec. 1	1864		5 0		20 0	6	.....	1 00	.....
Dec. 1	1865		5 0		20 0	2	.....	1 00	.....
Dec. 1	1866		5 0		20 0	2	.....	1 00	.....
Dec. 1	1867		5 0		20 0	3	.....	1 00	.....
Dec. 1	1868		5 0		20 0	3	.....	1 00	.....
Dec. 1	1869		5 0		20 0	2	.....	1 00	.....
Dec. 1	1870		5 0		20 0	3	.....	1 00	.....
Dec. 1	1871		5 0		20 0	3	.....	1 00	.....
Dec. 1	1872		5 0		20 0	2	.....	1 00	.....
Dec. 1	1873		5 0		20 0	3	.....	1 00	.....
Dec. 1	1874		5 0		20 0	2	.....	1 00	.....
Dec. 1	1875		5 0		20 0	3	.....	1 00	.....
Dec. 1	1876		5 0		20 0	2	.....	1 00	.....
Dec. 1	1877		5 0		20 0	1	.....	1 00	.....
Dec. 1	1878		5 0		20 0	2	.....	1 00	.....
Dec. 1	1879		5 0		20 0	3	.....	1 00	.....
Dec. 1	1880		5 0		20 0	2	.....	1 00	.....
Dec. 1	1881		5 0		20 0	3	.....	1 00	.....
Dec. 1	1882		5 0		20 0	4	.....	1 00	.....
Dec. 1	1883		5 0		20 0	3	.....	1 00	.....
Dec. 1	1884		5 0		20 0	3	.....	1 00	.....
Dec. 1	1885		5 0		20 0	2	.....	1 00	.....
Dec. 1	1886		5 0		20 0	2	.....	1 00	.....
Dec. 1	1887		5 0		20 0	2	.....	1 00	.....
Dec. 1	1888		5 0		20 0	4	.....	1 00	.....
Dec. 1	1889		5 0		20 0	2	.....	1 00	.....
Dec. 1	1890		5 0		20 0	4	.....	1 00	.....
Dec. 1	1891		5 0		20 0	1	.....	1 00	.....
Dec. 1	1892		5 0		20 0	2	.....	1 00	.....
Dec. 1	1893		5 0		20 0	2	.....	1 00	.....
Dec. 1	1894		5 0		20 0	1	.....	1 00	.....
Dec. 1	1895		5 0		20 0	4	.....	1 00	.....
Dec. 1	1896		5 0		20 0	1	.....	1 00	.....
Dec. 1	1897		5 0		20 0	2	.....	1 00	.....
Dec. 1	1898		5 0		20 0	3	.....	1 00	.....
Dec. 1	1899		5 0		20 0	1	.....	1 00	.....
Dec. 1	1900		5 0		20 0	1	.....	1 00	.....
Dec. 1	1901		5 0		20 0	1	.....	1 00	.....
Dec. 1	1902		5 0		20 0	3	.....	1 00	.....
Dec. 1	1903		5 0		20 0	3	.....	1 00	.....
Dec. 1	1904		5 0	Shell, 1.326	20 0	1 3	.....	1 00	.....
Dec. 1	1905		5 0		20 0	1 3	.....	1 00	.....

[Object of firing, to test strength of

P. M.									
Dec. 1	1906	Laflin & Rand's I. K., lot 7; density, 1.710; granulation, 2,360.	4 8	Shell, lot 326.	19 0 1 0 sand. 20 0	.....	02	1 00	.....
Dec. 1	1907		4 8		18 13 1 3 sand. 20 0	.....	01	1 00	.....
Dec. 1	1908		4 8		18 14 1 2 sand. 20 0	.....	03	1 00	.....
Dec. 1	1909		4 8		18 14 1 2 sand. 20 0	.....	04	1 00	.....

Arsenal, at Sandy Hook, N. J., December 1, 1891.

on score in top of powder chamber.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
16	From rear 5° right, 9 miles an hour.	.....	
15		Copper cylinder of 32,000 pounds initial compression and tables of 1890.	
16		.....	
15		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
15		.....	
15		.....	
15		.....	
15		.....	
15		.....	
16		.....	
15		.....	
16		Gun washed out and examined after this round.	
16		.....	
16		.....	
16		.....	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Fired to sea. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		.....	
16		Gun washed out and examined after this round.	
16		.....	
15		.....	
14		.....	
15		.....	
16		.....	
16		.....	
16		.....	
15		.....	
16		.....	
16		.....	
16		.....	
16		.....	

base of housing of Merriam fuse.]

10	From rear 5° right, 8 miles an hour.	Base depressed $\frac{1}{4}$ of an inch	Gun mounted on Buffington steel field carriage No. 4. Bow-spring brakes. Cannon friction primers, model 1887. Base of fuse in housing placed in bottom of cartridge bag. Fired to sea. Gun washed out and examined and impressions taken after this firing. Noticeable increase in depth of erosions around vent, and very marked increase in depth of erosions at slope of powder chamber and beginning of rifling. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
10		Base depressed $\frac{1}{4}$ of an inch	
10		Base depressed $\frac{5}{64}$ of an inch.....	
10		Base depressed $\frac{3}{32}$ of an inch.....	

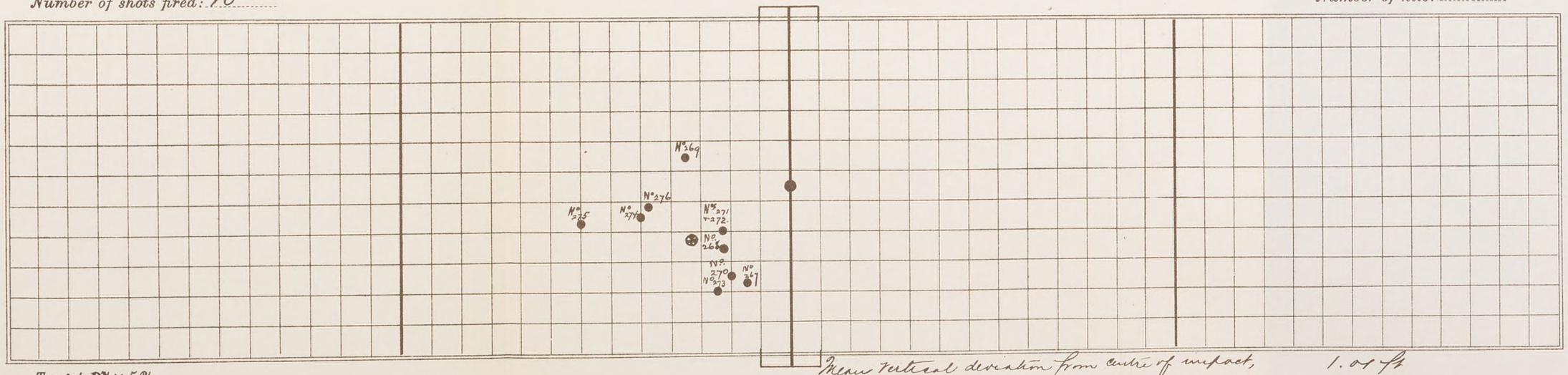
TARGET RECORD OF 3".6 B.L. Rifle (Steel) No. 1
Watervliet Arsenal
AT SANDY HOOK, N. J.
March 25th 1891

Sights for 3".2 Rifle used.

Target 1000 yards from Gun.

Number of shots fired: 10

Number of hits: 10



Target 12 × 52'.

Mean vertical deviation from centre of impact, 1.04 ft
Mean horizontal deviation from centre of impact, 1.41 ft
Mean deviation from centre of impact 1.73 ft

Gun sighted by Lieut. O. M. Lissak, O.D.
Target observed by Lieut. C.B. Wheeler, O.D.

Appendix 40, 1892.

Wind 9 *miles per hour.*

Amond M. Lissak
Lieut. Ord. Dept. U.S.A.

TARGET RECORD OF 3".6 B.L. Rifle Steel No 1
Watervliet Arsenal

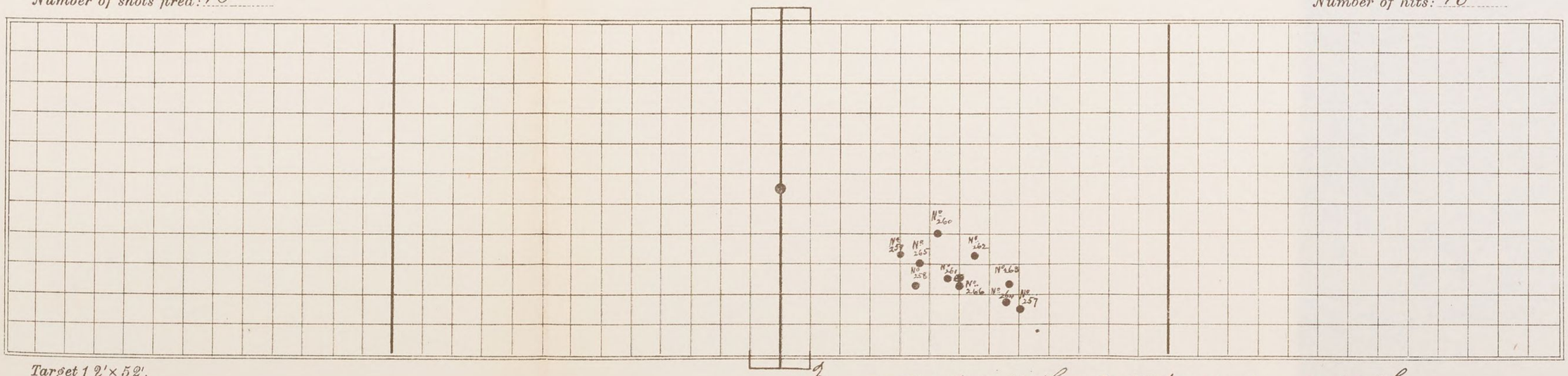
AT SANDY HOOK, N. J.
March 25th 1891.

Sights for 3".2 Rifle used.

Target 1000 yards from Gun.

Number of shots fired: 10

Number of hits: 10



Target 12'×52'.

Mean vertical deviation from centre of impact,	0.62 ft.
Mean horizontal deviation from centre of impact,	1.15 ft.
Mean deviation from centre of impact,	1.306 ft

Gun sighted by Lieut. O. M. Lissak, O.D.
Target observed by Lieut. C.B. Wheeler, O.D.

Ormond M. Lissak
Lieut. Ord. Dept. U.S.A.

Wind 9 miles per hour.

Ord 52.2

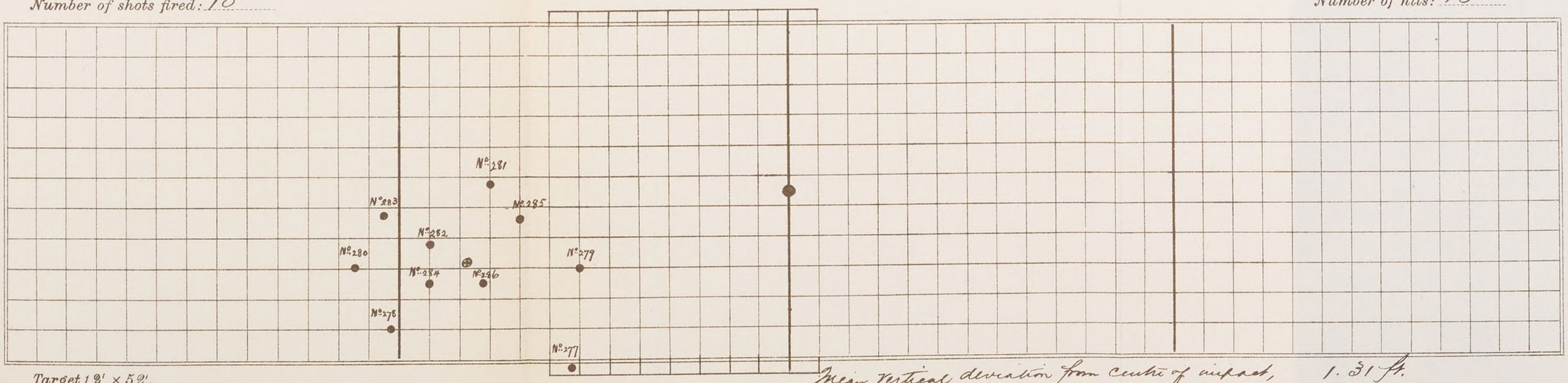
TARGET RECORD OF 3.6 B.L. Rifle (Steel) No 1
Watervliet Arsenal
AT SANDY HOOK, N. J.
March 25th 1891.

Sights for 3.2 Rifle used.

Target 1000 yards from Gun.

Number of shots fired: 10

Number of hits: 10



Target 12' × 52'.

Mean vertical deviation from centre of impact,	1.31 ft.
Mean horizontal deviation from centre of impact,	2.175 ft.
Mean deviation from centre of impact,	2.539 ft.

Gun sighted by Lieut. O. M. Lissak, O.D.
Target observed by Lieut. C.B. Wheeler, O.D.

Appendix 40, 1892.

Wind 9 miles per hour.

Ormond M. Lissak
Lieut. Ord. Dept. U.S.A.

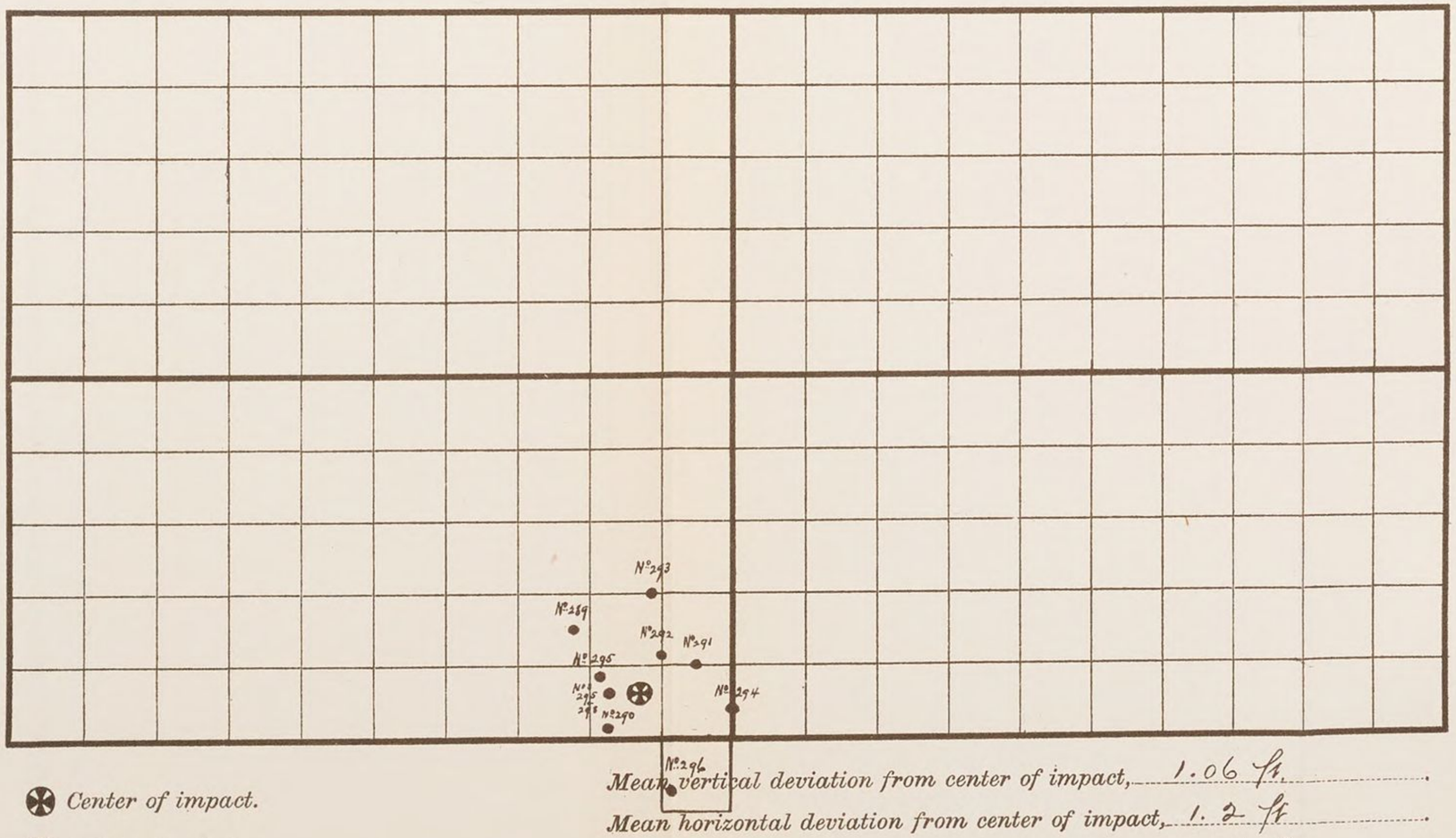
TARGET RECORD OF 3 1 C

TARGET RECORD of 3"6 B.L. Rifle (Steel) No. 1
Watervliet Arsenal
AT SANDY HOOK, N. J.
March 26th 1891

Sights for 3"6 Rifle used.
Peep rear sight. Cross hair front sight.

Target 1 Mile *from Gun.*

Number of shots fired, 10. *Direct hits,* 10. *Ricochet hits,* 0. *Misses,* 0.



✠ *Center of impact.*

✠ *Point aimed at.*

Target 25' × 40'.

Mean vertical deviation from center of impact, 1.06 ft.

Mean horizontal deviation from center of impact, 1.2 ft

Mean deviation from center of impact, 1.6 ft.

Gun sighted by Lieut. O. M. Lissak, O.D.
Target observed by Lieut. C.B. Wheeler, O.D.

Appendix 40, 1892.

Wind 8 *miles per hour.*

Ormond M. Lissak
Lieut. Ord. Dept. U.S.A.

TARGET RECORD of 3·6 B. L. Rifle (Steel) No. 1

Watervliet Arsenal

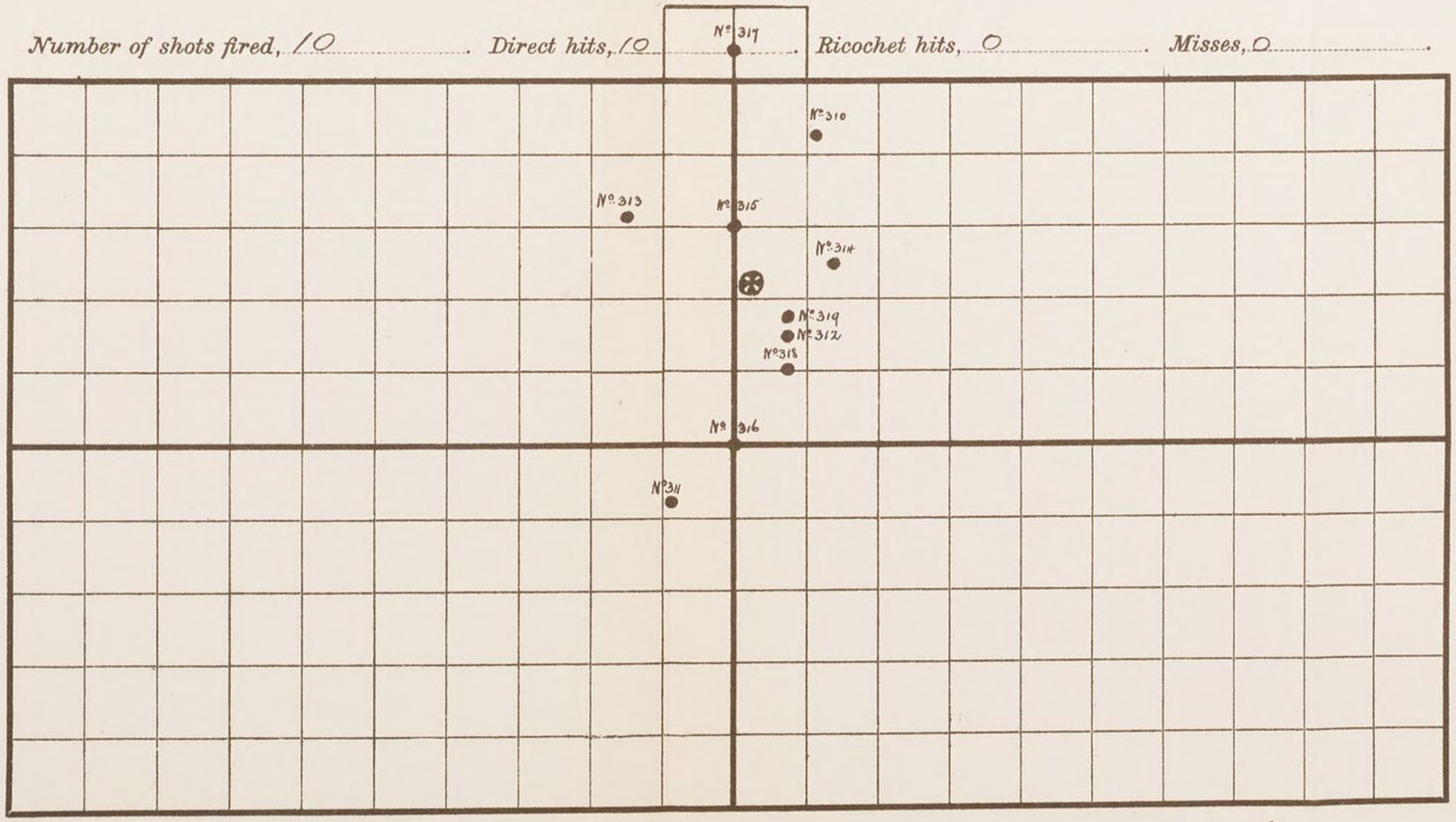
AT SANDY HOOK, N. J.

March 31st 1891

Sights for 3·6 Rifle used.
Peep rear sight. Cross hair front sight.

Target 1 Mile *from Gun.*

Number of shots fired, 10. *Direct hits,* 10. *Ricochet hits,* 0. *Misses,* 0.



✠ *Center of impact.*

✠ *Point aimed at.*

Mean vertical deviation from center of impact, 2.95 ft.

Mean horizontal deviation from center of impact, 1.425 ft.

Mean deviation from center of impact, 3.276 ft.

Target 2½' × 40'

Gun sighted by Lieut. O. M. Lissak O.D.
Target observed by Lieut. C. B. Wheeler O.D.

Appendix 40, 1892.

Wind 22 *miles per hour.*

Charles D. Rhodes
Lieut. Ord. Dept. U. S. A.

TARGET RECORD of 3'6 B.L. Rifle (Steel) No. 1
Watervliet Arsenal

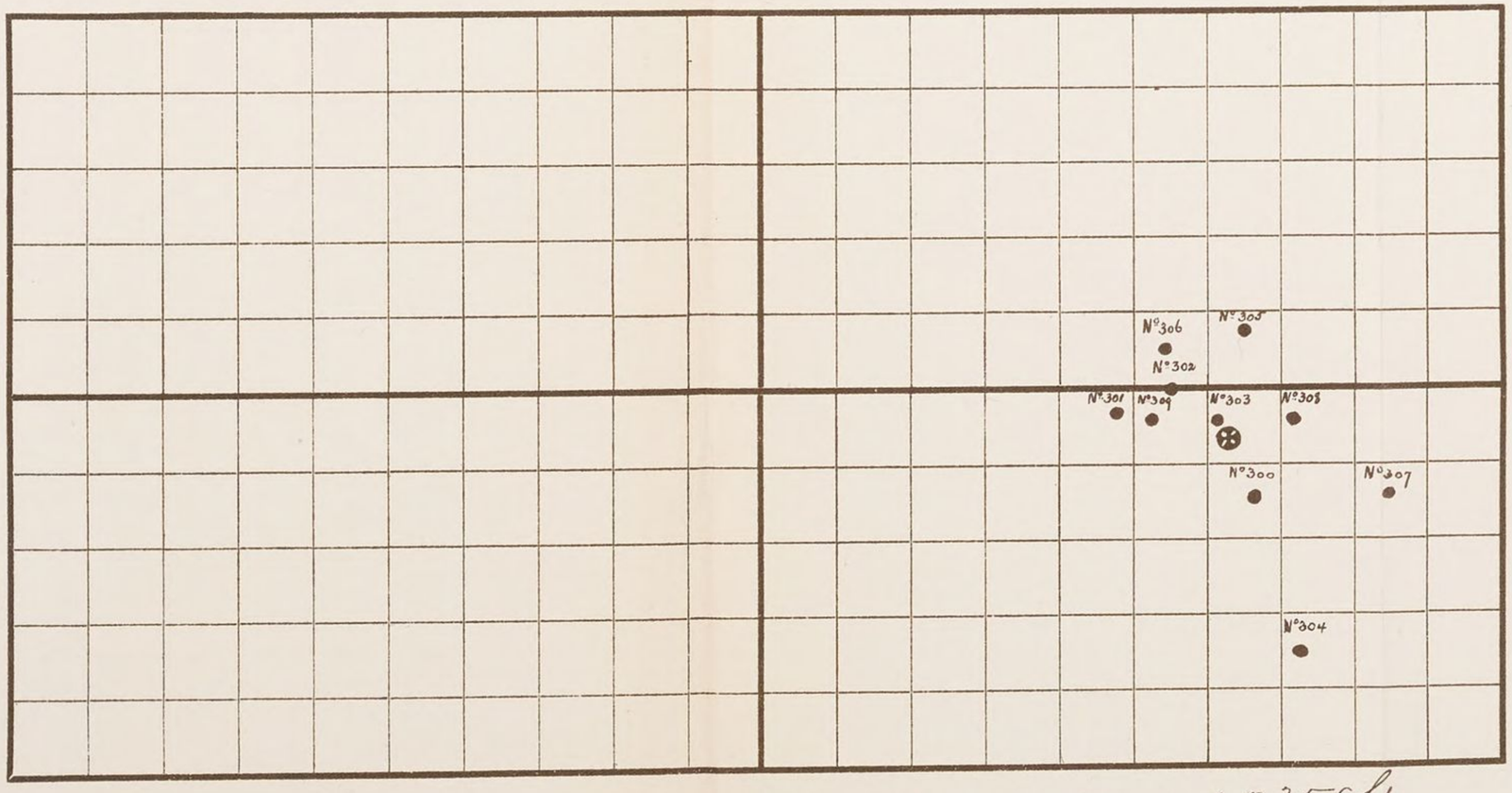
AT SANDY HOOK, N. J.

March 31st 1891.

Sights for 3'6 Rifle used.
Peep rear sight Cross hair front sight.

Target 1 Mile *from Gun.*

Number of shots fired, 10 . *Direct hits,* 10 . *Ricochet hits,* 0 . *Misses,* 0 .



✠ *Center of impact.*

✪ *Point aimed at.*

Mean vertical deviation from center of impact, 1.735 *ft.*

Mean horizontal deviation from center of impact, 1.8 *ft.*

Mean deviation from center of impact, 2.5 *ft.*

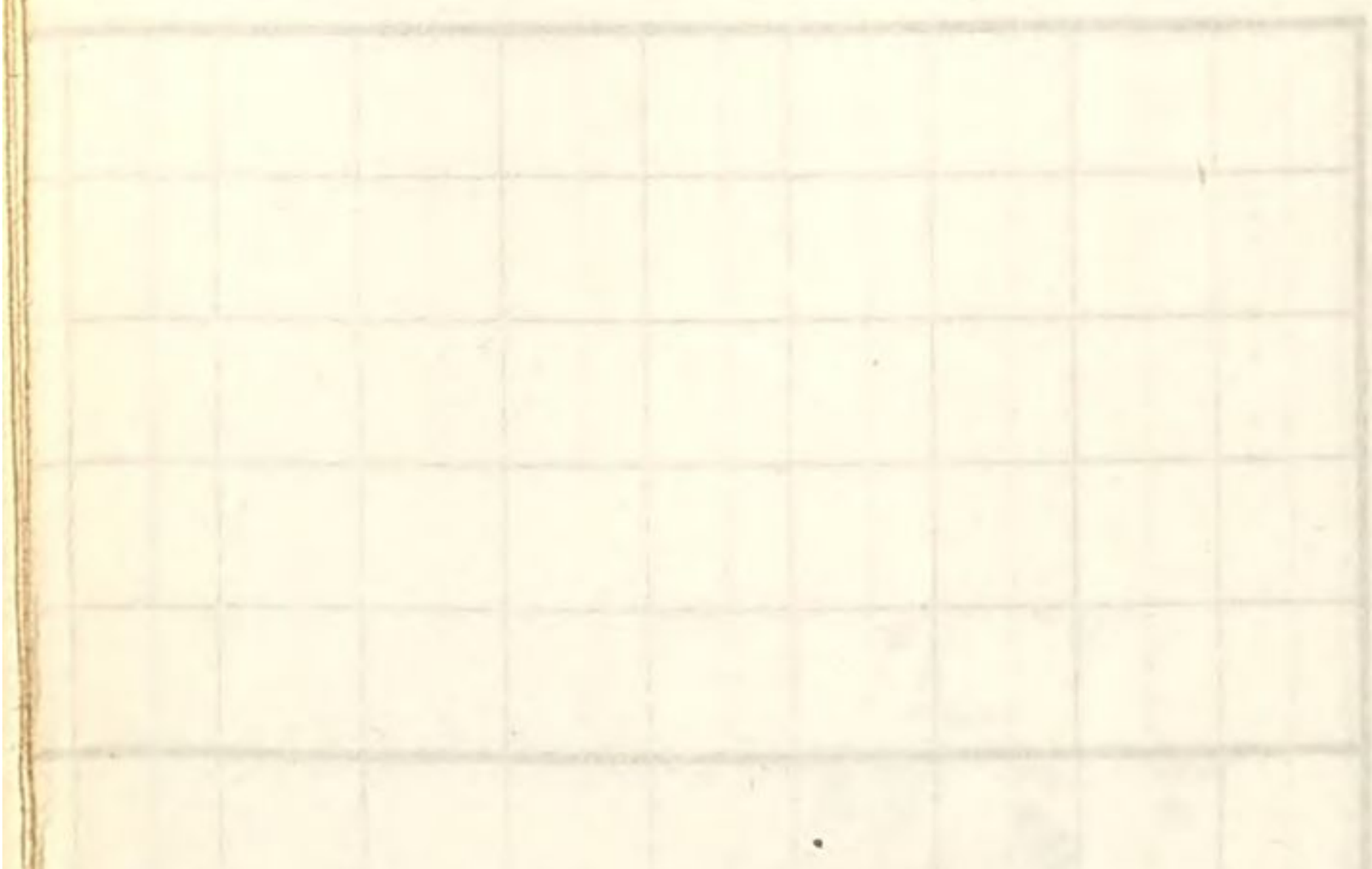
Target 20' × 40'.

Gun sighted by Lieut. O. M. Lissak, O.D.
Target observed by Lieut. C.B. Wheeler, O.D.

Appendix 40, 1892.

Wind 22 *miles per hour.*

Charles B. Wheeler
Lieut. Ord. Dept. U.S.A.



TARGET RECORD of 3.6 B.L. Field Rifle (Steel) No 1. Watervliet Arsenal

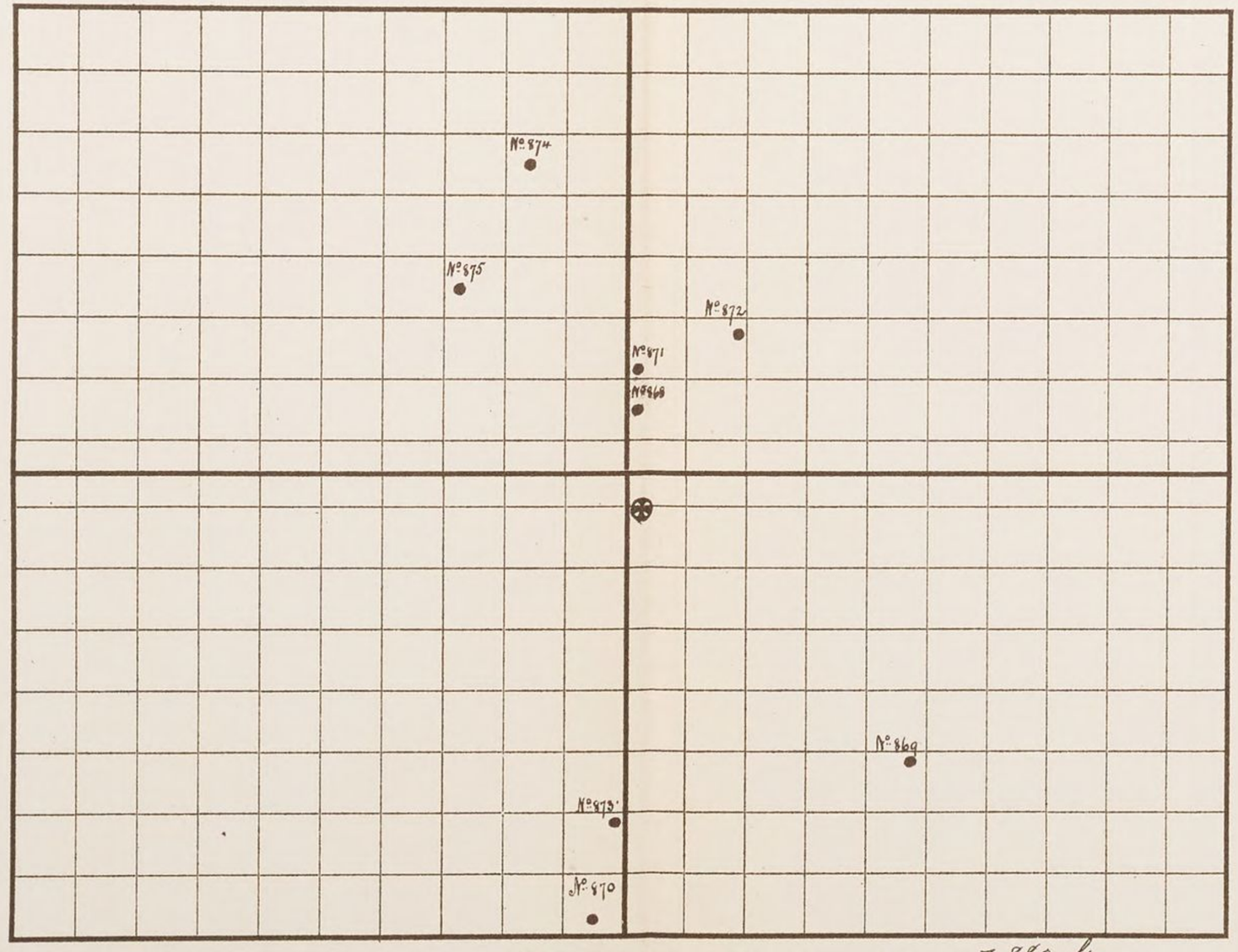
Scott's sight used.

AT SANDY HOOK, N. J.

May 20th 1891.

Target 3000 yards *from Gun.*

Number of shots fired, 8 . *Direct hits,* 8 . *Ricochet hits,* 0 . *Misses,* 0 .



✪ *Center of impact.*

✪ *Point aimed at.*

Mean vertical deviation from center of impact, 7.882 ft.

Mean horizontal deviation from center of impact, 3.077 ft.

Mean deviation from center of impact, 8.461 ft.

Target 30′ × 40′.

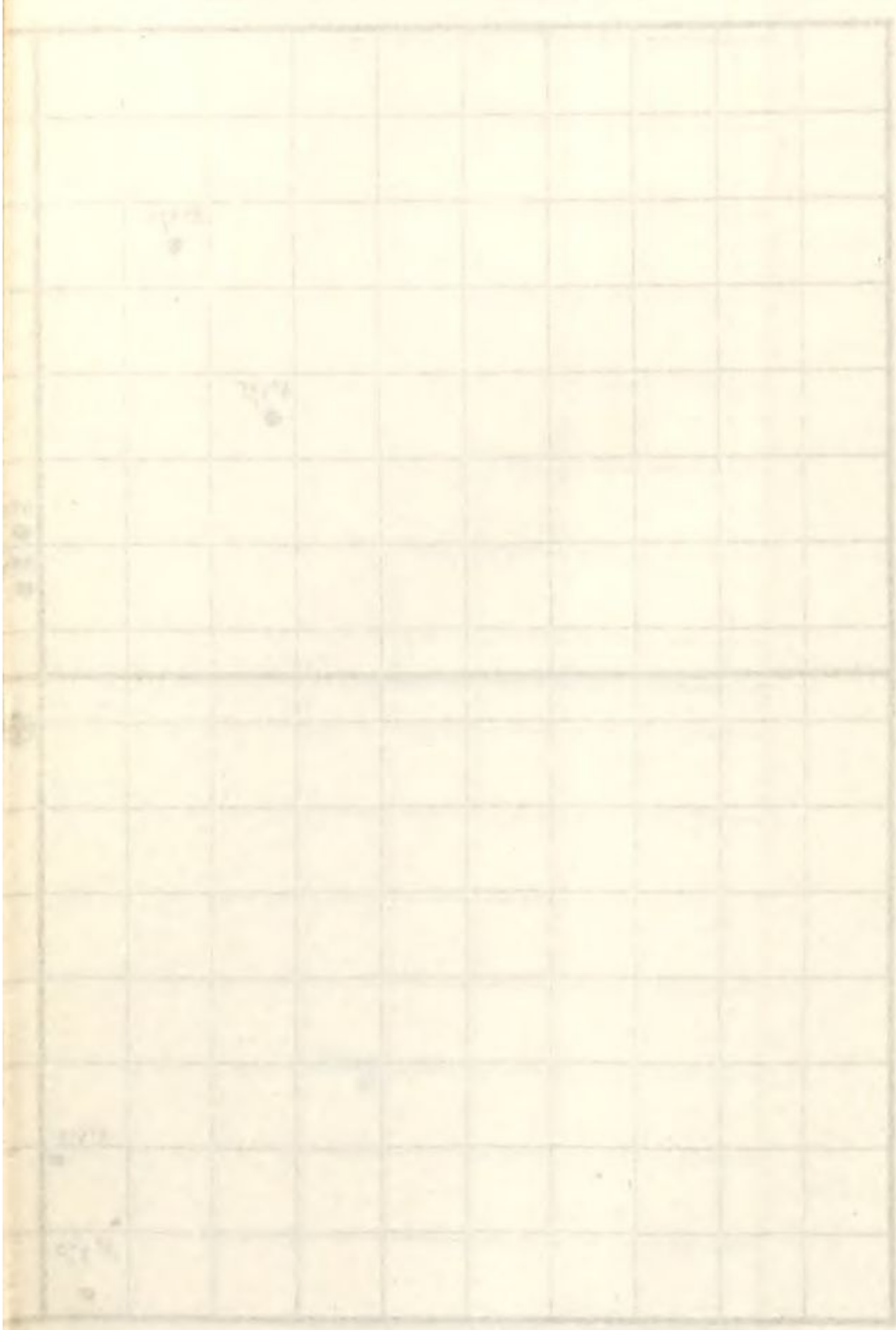
Gun sighted by Lieut. W. W. Gibson, O.D.
Target observed by Lieut. C.B. Wheeler, O.D.

Wind 10 *miles per hour.*

Ord 52 2

Appendix 40, 1892.

Charles D. Wheeler
Lieut. Ord. Dept. U.S.A.



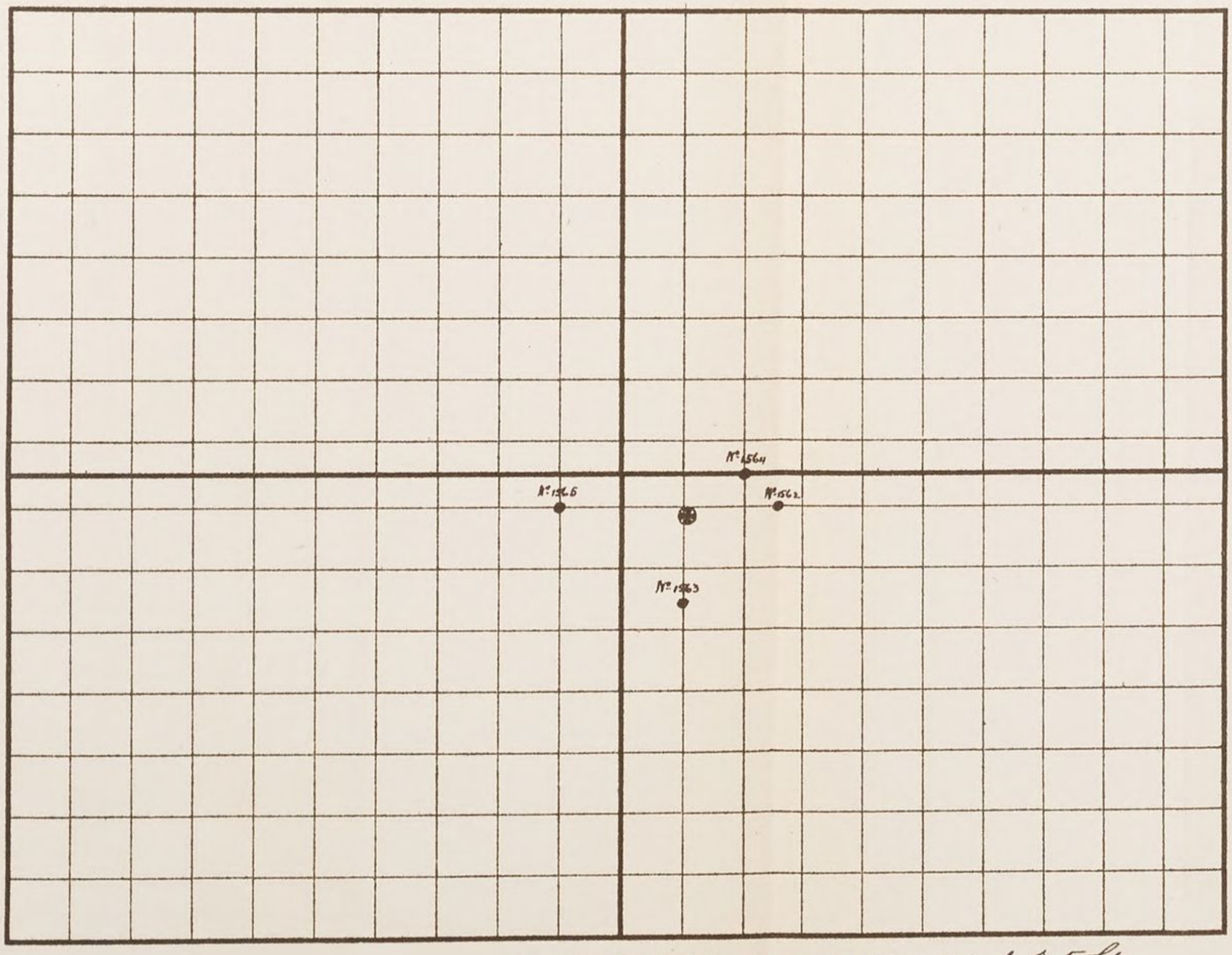
TARGET RECORD of 3.6 B.L. Rifle Steel No. 1
Watervliet Arsenal.

Scotts sight used.

AT SANDY HOOK, N. J.
September 11th 1891

Target 300 yards *from Gun.*

Number of shots fired, 5 . *Direct hits,* 4 . *Ricochet hits,* 0 . *Misses,* 1 .



✠ *Center of impact.*

✠ *Point aimed at.*

Target 30' × 40'.

Mean vertical deviation from center of impact, 1.25 ft.

Mean horizontal deviation from center of impact, 2.25 ft.

Mean deviation from center of impact, 2.57 ft.

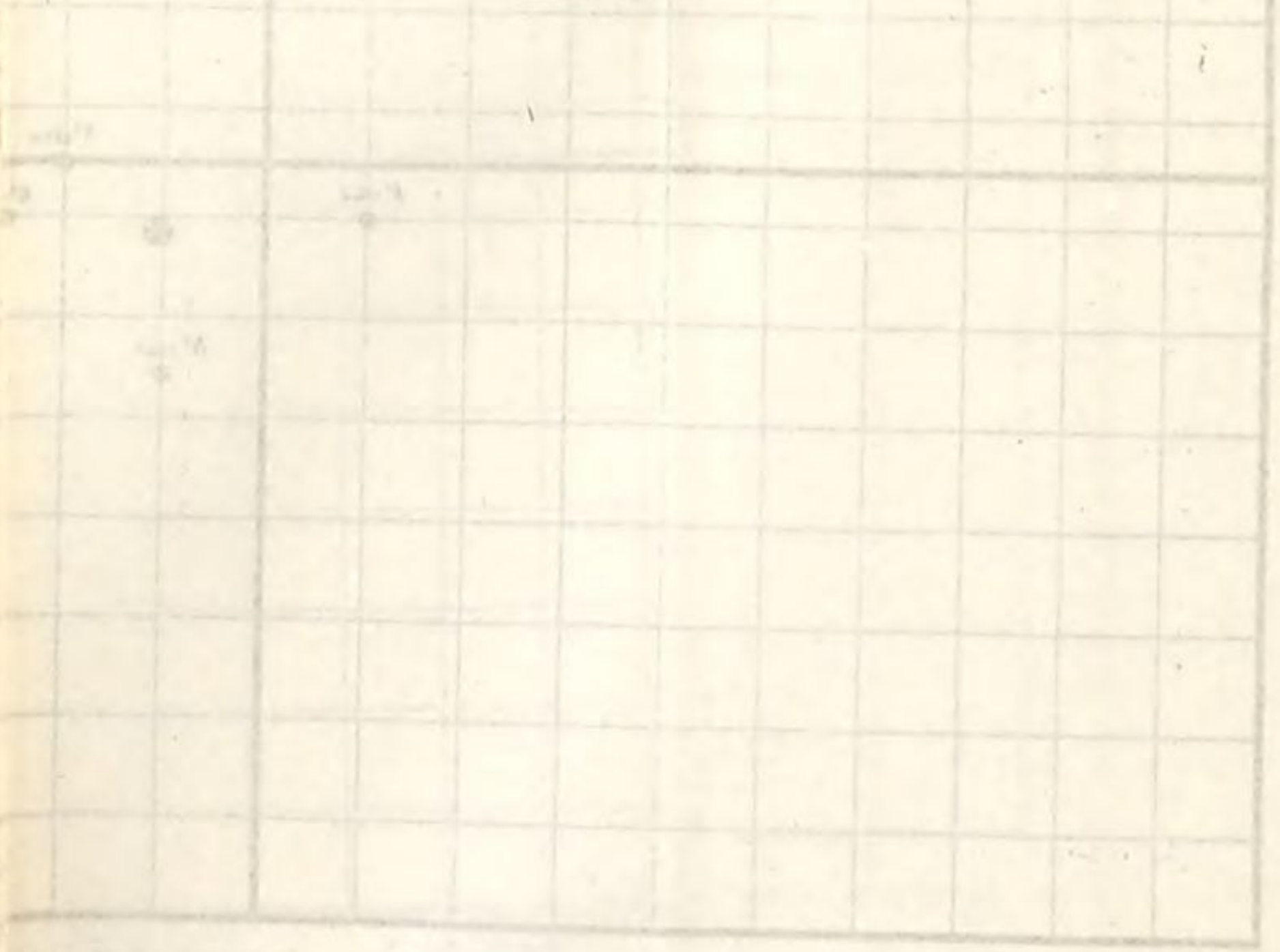
Gun sighted by Lieut. C. B. Wheeler, O.D.
Target observed by Pvt. Burt, Ord. Det.

Wind 4 *miles per hour.*

Appendix 40, 1892.

Charles B. Wheeler
Lieut Ord. Dept. U.S.A.

TARGET RECORD



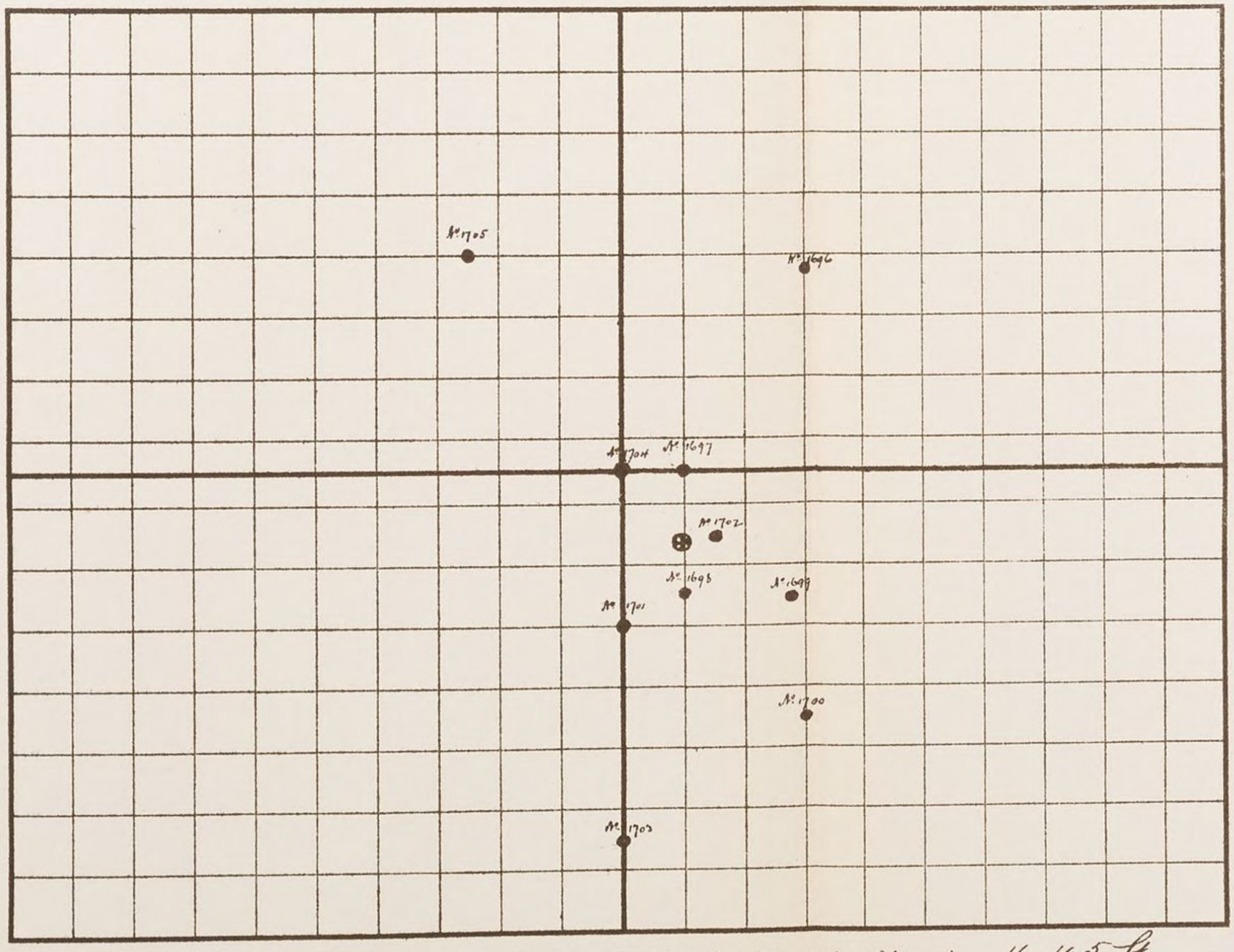
TARGET RECORD of 3.6 B.L. Rifle (Steel) No 1
Watervliet Arsenal.

AT SANDY HOOK, N. J.

September 21st 1891.

Sights for 3.6 Rifle used.
Peep rear sight, cross hair front sight. Target 3000 yards from Gun.

Number of shots fired, 10. *Direct hits,* 10. *Ricochet hits,* 0. *Misses,* 0.



✪ *Center of impact.*

✪ *Point aimed at.*

Mean vertical deviation from center of impact, 4.45 ft.

Mean horizontal deviation from center of impact, 2.56 ft.

Mean deviation from center of impact, 5.13 ft.

Target 30' × 40'.

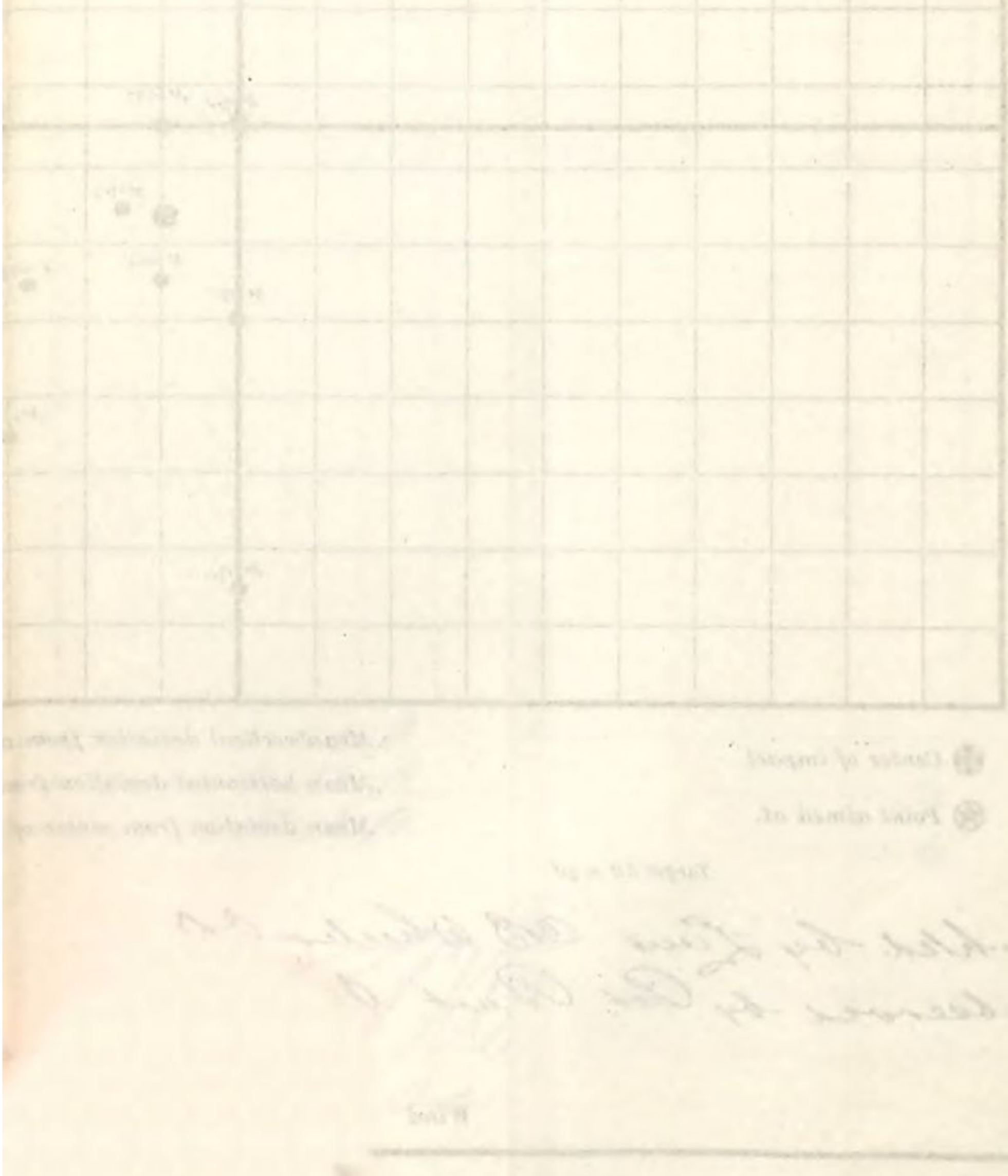
Gun sighted by Lieut. C.B. Wheeler, O.D.
Target observed by Pvt. Burt, Ord. Det.

Appendix 40. 1892.

Wind 6 *miles per hour.*

Charles B. Wheeler
Lieut. Ord. Dept.

TARGET RECORD



Sights for 3."6 Rifle used.
Peep rear sight, cross hair front sight

TARGET RECORD of 3."6 B. L. Rifle (Steel) No. 1

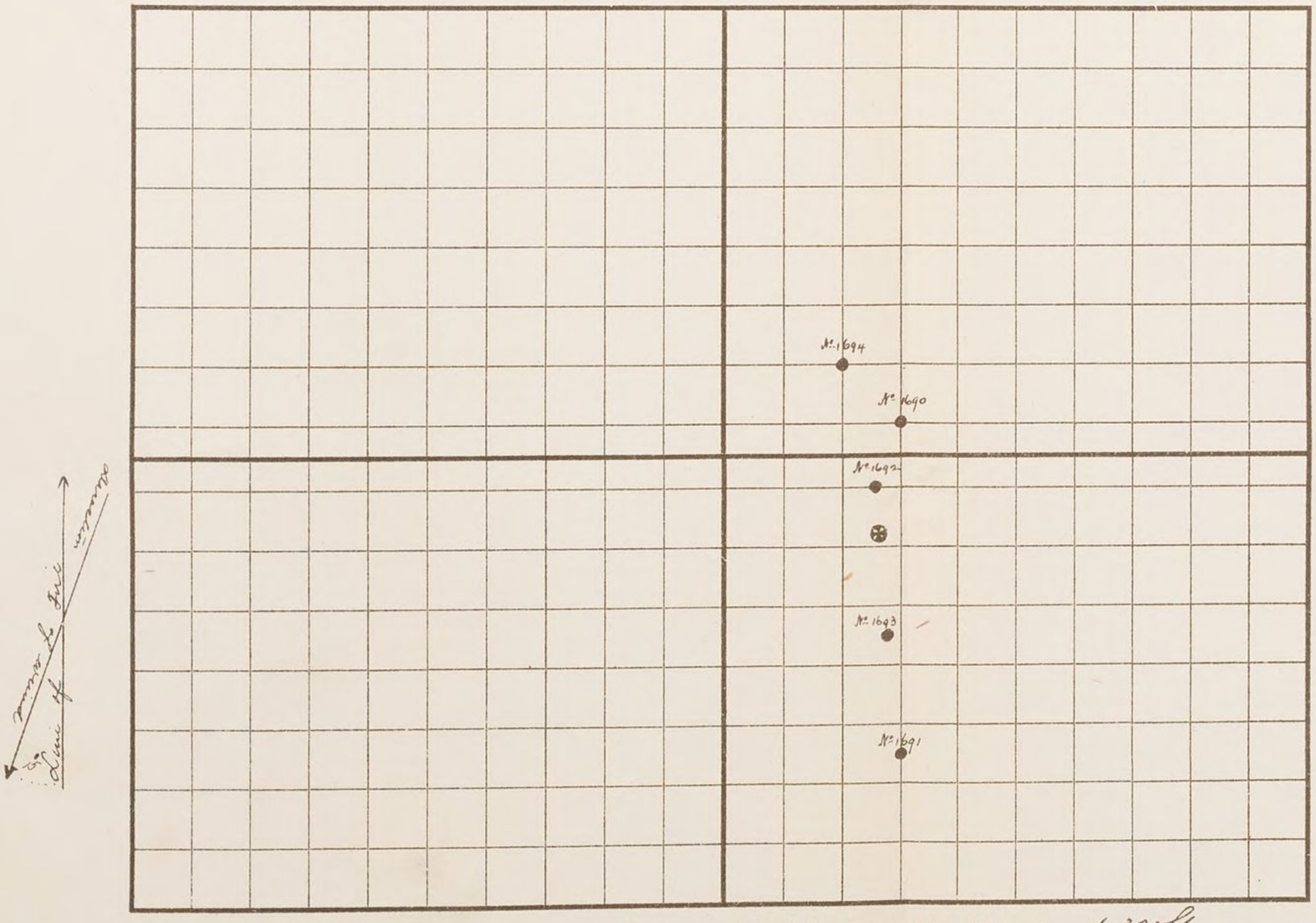
Watervliet Arsenal.

AT SANDY HOOK, N. J.

September 21st 1891.

Target 3000 yards *from Gun.*

Number of shots fired, 5 . *Direct hits,* 5 . *Ricochet hits,* 0 . *Misses,* 0 .



✠ *Center of impact.*

✪ *Point aimed at.*

Target 30' × 40'.

Mean vertical deviation from center of impact, 4.32 ft.

Mean horizontal deviation from center of impact, 0.64 ft.

Mean deviation from center of impact, 4.36 ft.

Gun sighted by Lieut. C.B. Wheeler, Ord.
Target observed by Pvt. Burt, Ord. Det.

Wind 6 *miles per hour.*

Charles B. Wheeler
Lieut Ord. Dept.

Appendix 40, 1892.

APPENDIX 41.

PROGRESS REPORT ON THE TESTS OF THE HOTCHKISS 3-INCH B. L. MOUNTAIN RIFLE BY THE BOARD FOR TESTING RIFLED CANNON. ETC., APPOINTED UNDER THE ACT OF CONGRESS APPROVED JULY 5, 1884.

(8 plates.)

The Hotchkiss 3-inch B. L. mountain rifle was turned over to this board at the Ordnance Proving Ground, Sandy Hook, N. J., for trial, in accordance with instructions of the Chief of Ordnance, U. S. Army, dated December 26, 1891.

GENERAL DESCRIPTION OF THE PIECE.

The piece is a short rifle, with sliding breechblock, and designed originally for the use of fixed ammunition. The needs of the service requiring the use of full and a half charges in the piece, the cartridge cases have been cut down and in all the firings by the board the projectile and charge have been inserted separately. The charge is ignited by a friction primer placed in a vent at the top of the breech and passing through the breechblock.

The piece is mounted on a two-wheeled carriage provided with a limber for traveling purposes and for transportation of ammunition. Recoil is checked by means of two ropes fastened to the end of the trail and passing between the spokes of the wheels.

Total length of gun	inches..	46.7
Length of bore	calibers..	14
Weight of gun	pounds..	218
Weight of projectile	do....	12
Bursting charge, common shell	ounces..	6.3
Bursting charge, shrapnel	do....	1.75
Balis in shrapnel	number..	160
Total weight of carriage	pounds..	319
Rounds carried in limber	number..	32
Total weight of limber, loaded	pounds..	1,005
Total weight of full equipment	do....	1,545

The piece is designed to withstand pressures not exceeding 14,225 pounds per square inch.

TEST OF THE PIECE.

The board fixed upon the following programme for the test of this piece.

Test for endurance.

The gun to be fired for endurance 1,000 rounds or as near 1,000 as can be fired with the projectiles at the disposal of the board, using projectiles of 12 pounds weight, and pressures not to exceed 14,225 pounds. Velocities and pressures to be taken and the gun to be star-gauged as often as the board may deem necessary.

Rapidity.

Three groups of 20 rounds each.

Accuracy and range.

The following tests to be made for accuracy and range:

With direct fire.—One target of 10 rounds at a range of 1,000 yards. One target of 10 rounds at a range of 1 mile. These targets to be made with full charges.

With vertical fire, using half charges.—Four targets of 5 rounds each at each angle of elevation, as follows: 5°, 10°, 15°, 20°.

Using full charges.—Four targets of 5 rounds each at such angles of elevation as will best cover the range between 2,000 yards and the maximum range of the piece.

Shrapnel firing.

The following tests to be made with shrapnel, using full charges: Two tests of 5 rounds each at ranges, respectively, of 1,000 yards and 1 mile to determine efficiency of the shrapnel; one test to determine maximum range of effectiveness of shrapnel; three targets of 8 rounds each to determine accuracy of shrapnel at the same ranges.

FIRINGS.

The piece had been fired 99 rounds before it came into the hands of the testing board. Of these, 41 rounds had been fired by the manufacturers in France, and the remaining 58 at the proving ground at Sandy Hook, N. J. At this date 552 rounds have been fired, including those fired by the manufacturers. Over 450 rounds have been fired with full charges.

PROJECTILES.

For the test of the piece, there were turned over to the board 89 common shell, 97 shrapnel, and 300 cylindrical shot. The shell and shrapnel were reserved for range and accuracy firing and the cylindrical shot were used in the butt firings for endurance. The cylindrical shot were provided with a rotating band near the base and a steadying band near the head, while the shell and shrapnel have but one band, for rotation, near the base. The steadying band on the cylindrical shot being sometimes slightly too great in diameter, there was occasional difficulty experienced in ramming these shot to their proper place in the bore. This difficulty was not encountered in the use of the shell or shrapnel.

POWDER.

The powder used in the test of the piece by the board was Du Pont's I. K. H., lot 27, having a density of 1.725 and a granulation of 2,605.

The following table embodies the results of the tests of this powder in the piece:

[Weight of shot, cylindrical, 12 pounds.]

Charge.	No. of rounds.	Mean velocity, 75 feet from muzzle.	Mean pressure.
Ounces.			*Pounds.*
13	3	866	19.113
12½	1	840	17.395
12	3	818	15.993
11	3	770	14.118

RANGE AND ACCURACY.

The firings for range and accuracy have at this date been only partially completed. Tests have been made with direct and high-angle fire. They indicate in successive rounds with the same charge a greater variation in range than in deviation from the plane of fire. The maximum range thus far obtained is 3,475 yards, with a charge of 11 ounces; projectile of 11 pounds 11 ounces and an elevation of 20°.

RAPIDITY.

Three tests have been made for rapidity. On account of the necessity of reserving the common shell for accuracy firings, cylindrical shot were used in the tests, and the occasional difficulty of properly seating these shot, as noted above, rendered the firings less rapid than they otherwise would have been. Twenty rounds, Nos. 90 to 109, inclusive, were fired in 14 minutes 18 seconds. The first ten of the twenty were fired in 7 minutes 5 seconds; the last ten in 7 minutes and 13 seconds. Twenty rounds, Nos. 120 to 139, inclusive, were fired in 21 minutes. Twenty rounds, Nos. 178 to 197, inclusive, were fired in 16 minutes 35 seconds. The first ten of the twenty were fired in 8 minutes; the last ten in 8 minutes 35 seconds.

ENDURANCE.

The piece has thus far been fired 552 times. At round 66 one thread of the locking screw of the breechblock was found broken. The threads in recess for block were burred; 4 rounds were fired with breech in this condition. A new locking screw, made at Sandy Hook, was then inserted and the burrs removed from block and from threads in recess. At round 197 it was noticed that the locking screw was again broken. This broken screw is still in the piece, 273 rounds having been fired with it in its broken condition. The working of the breechblock continues satisfactory. The rear edge of the powder chamber—the intersection of the bore and the slot for breechblock—was occasionally burred by being struck by the end of the rammer in forcing the projectile home. The burrs scraped the cartridge case in

its insertion and sometimes made the closing of breechblock difficult. The cartridge cases can not as a rule be used oftener than five times in succession when the full charge is employed. After being cleaned and dried they can be used again. One case was, however, used in 20 rounds without cleaning—in rounds 198 to 204 and in rounds 225 to 237. Deformation of the cartridge case caused occasional difficulty in closing the breech.

THE CARRIAGE.

After round 139 it was found that the nuts on bolts through hubs of wheels were loose and that the wheels were very shaky. The nuts were tightened after this round. At round 221 it was again noted that the nuts on these bolts were so loose as to be easily turned by hand. The ropes used for restraining recoil frequently became unhooked from trail handles. When lashings of wire were put over the points of the hooks the difficulty was obviated.

CONCLUSION.

The board concludes that in the tests, as far as they have been carried out, the performance of the piece has been satisfactory. No material damage has resulted to the piece. It has been subjected to the rapid firing that such a piece would be likely to be subjected to in actual battle. The board is therefore of opinion that pieces of this type may safely be put to use in the Government service.

All firing, target, and star-gauge records are forwarded as a part of this report.

F. H. PARKER,
Lieutenant-Colonel, Ord. Dept., President.
CLIFTON COMLY,
Major, Ordnance Department, U. S. Army.
J. W. REILLY,
Major, Ordnance Department, U. S. Army.
FRANK HEATH,
Captain, Ordnance Department.
ORMOND M. LISSAK,
Lieutenant, Ord. Dept., U. S. Army, Recorder.

GOVERNOR'S ISLAND, NEW YORK HARBOR, *June 13, 1892.*

(2918–'92.)

Star-gauging of 3-inch Hotchkiss mountain gun, No. 168 (weight 219 pounds), at Sandy Hook proving ground, November 5, 1891.

[3-inch ring and points.]

From muzzle.	After 40 rounds, Nov. 5, 1891.	After 505 rounds, June 10, 1892.	Increase.	From muzzle.	After 40 rounds, Nov. 5, 1891.	After 505 rounds, June 10, 1892.	Increase.
Inches.				*Inches.*			
0	2.99	3.002	.012	17	2.997	3.002	.005
1	2.99	3.0015	.0115	18	2.998	3.002	.004
2	2.99	3.0015	.0115	19	2.997	3.002	.005
3	2.99	3.0015	.0115	20	2.998	3.0025	.0045
4	2.99	3.0015	.0115	21	3.998	3.002	.004
5	2.991	3.0015	.0115	22	2.997	3.003	.006
6	2.992	3.002	.010	23	2.997	3.003	.006
7	2.9925	3.002	.0105	24	2.9965	3.003	.0065
8	2.993	3.002	.009	25	2.996	3.002	.006
9	2.9935	3.002	.0085	26	2.9955	3.0025	.0070
10	2.9935	3.002	.0085	27	3.9955	3.0025	.0070
11	2.994	3.002	.008	28	3.996	3.0035	.0075
12	2.995	3.002	.007	29	2.998	3.0035	.0055
13	2.996	3.0015	.0055	30	3.000	3.004	.004
14	2.996	3.0015	.0055	31	3.0045	3.007	.0025
15	2.996	3.002	.006	32	3.007	3.01	.003
16	2.9965	3.002	.0055	33	3.014	3.016	.002

Firing record of Hotchkiss 3-inch mountain gun, No. 168, June 17 to October 7, 1890, at St. Denis, France.

Round No.	Powder. Kind.	Charge.	Density of loading.	Projectile. Kind.	Weight.	Pressure at the breech.	Velocity. Instrumental.	Initial.	Recoil.	Remarks.
		Grams.			*Kilos.*	*Kilos.*	*Meters.*	*Meters.*	*Meters.*	
1	C. 2.....	275	0.623	Common shell.	5.450	611	193.5	193.9	4.150	Shell fused but unloaded. All fuses acted except the first, for which the velocity proved too low.
2	C. 2.....	325	0.736		5.450	851	231.9	232.6	4.150	
3	C. 2.....	375	0.849		5.450	919	245.9	246.6	4.680	
4	C. 2.....	400	0.906		5.450	984	256.7	257.4	5.220	
5	C. 2.....	400	0.906		5.450	.....	.....	.....	.....	
6	C. 2.....	400	0.906		5.450	.....	.....	.....	.....	
7	C. 2.....	400	0.906		5.450	.....	.....	.....	.....	
8	C. 2.....	400	0.906		5.450	.....	.....	.....	.....	
9	C. 2.....	400	0.906		5.450	.....	.....	.....	.....	
10	C. 2.....	400	0.906		5.450	.....	.....	.....	.....	
11	C. 2.....	400	0.906		5.450	705	247.9	.....	5.250	
12	C. 2.....	400	0.906		5.450	932	256.7	.....	5.250	
13	C. 2.....	400	0.906		5.450	996	257.6	.....	5.250	
14	C. 2.....	400	0.906		5.450	824	253.4	.....	5.250	
15	C. 2.....	410	0.929		5.450	.....	.....	.....	5.700	
16	C. 2.....	410	0.929		8.450	879	251.0	.....	5.700	
17	C. 2.....	410	0.929		8.450	958	255.7	.....	5.700	
18	C. 2.....	410	0.929		8.450	919	250.7	.....	5.700	
19	C. 2.....	410	0.929		8.450	919	250.7	.....	5.700	
20	C. 2.....	400	0.906		8.450	1,033	262.0	262.7	4.450	
21	C. 2.....	400	0.906		8.450	1,045	261.5	262.2	4.500	
22	C. 2.....	400	0.906		8.450	996	256.7	257.4	4.250	
23	C. 2.....	400	0.906		8.450	1,009	258.7	259.4	4.350	
24	C. 2.....	400	0.906	Shrap.	5.467	.....	250.0	250.7	4.600	Shrapnel with combination fuse; the fuse acted.
25	C. 2.....	410	0.929		5.450	1,045	260.0	260.7	5.100	
26	C. 2.....	410	0.929	Common shell.	5.450	1,009	260.8	261.5	4.850	
27	C. 2.....	410	0.929		5.450	958	258.9	259.6	5.100	
28	C. 2.....	410	0.929		5.450	919	257.2	257.9	4.650	
29	C. 2.....	400	0.906		5.450	.....	260.2	260.9	4.300	
30	C. 2.....	400	0.906		5.450	.....	248.9	.....	4.700	
31	C. 2.....	400	0.906		5.450	.....	255.7	256.4	4.300	
32	C. 2.....	400	0.906		5.450	.....	244.3	.....	4.500	
33	C. 2.....	400	0.906		5.450	.....	257.7	258.4	4.900	
34	C. 2.....	400	0.906		5.450	.....	252.2	253.1	4.850	
35	C. 2.....	400	0.906		5.450	.....	254.7	255.4	4.800	
36	B. N. C.	125	0.283		5.450	529	198.6	199.1	2.650	Smokeless powder.
37	B. N. C.	175	0.397		5.450	892	257.7	258.4	4.300	
38	B. N. C.	200	0.453		5.450	1,190	288.6	289.5	5.300	
39	B. N. C.	200	0.453		5.450	1,159	291.8	292.7	6.700	Gun star-gauged. See report.
40	C. 2.....	400	0.906		5.450	.....	.....	.....	.....	
41	C. 2.....	400	0.906		5.450	.....	.....	.....	.....	

Record of firing with Hotchkiss 3-inch mountain gun, No. 168

[Object of firing,

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Fuse.	Elevation.	Instrumental velocity, 100 feet from muzzle.	Pressure per square inch of bore.
			Ounces.		*Lbs. Oz.*		′		*Pounds.*
P. M.	1	Du Pont's L. K. H., lot 16; density, 1.725; granulation, 2,524.	10	Hotchkiss common shell, lot 293.	11 7½ 8½ sand. 12 0	Hotchkiss point percussion fuse (small), No. 2.	00	Lost	No. 5, less than 9,000.
	2		10		11 5½ 10½ sand. 12 0		10	Lost .... 50+½ 75 *feet.*	No. 5, 9,075
	3		12		11 5½ 10½ sand. 12 0		10	Lost .... 50+½	No. 5, 13,020
	4		13		11 5 11 sand. 12 0		15	.....	No. 5, 14,200

Record of firing with Hotchkiss 3-inch mountain gun, No. 168

[Object of firing,

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Fuse.	Fuse set at seconds.	Elevation.	Instrumental velocity, 75 feet from muzzle.
			Oz.		*Lbs. Oz.*			° ′	*Feet.*
A. M.	5	Du Pont's L. K. H., lot 16; density, 1.725; granulation, 2,524.	13	Hotchkiss common shell, lot 293.	11 5½ 10½ sand. 12 0	Hotchkiss point percussion fuse (small), No. 2.	.....	0 05	793
	6		13		11 5 11 sand. 12 0		.....	0 10	Lost..
	7		14		11 6¼ 9¾ sand. 12 0		.....	0 15	850
	8		13½		11 6 10 sand. 12 0		.....	0 15 50+½	819
	9		13½		11 6 8½ rifle powder, bursting charge. 11 14½		.....	8 00	
	10		13½		11 6 8½ rifle powder, bursting charge. 11 14½		.....	4 00	.....
	11		13½		11 4½ 8½ rifle powder, bursting charge. 11 13		.....	4 10	.....

(*weight 219 pounds*), *at Sandy Hook, N. J., January 14, 1891.*

to test gun.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
15	From right and rear, 23 miles an hour.	Three wads placed between powder and shell; velocity wires not cut. Copper cylinders of 9,000 pounds initial compression and tables of 1887.	Gun mounted on Hotchkiss mountain gun carriage.
15		Three wads placed between powder and shell; velocity wires not cut.	Cannon friction primers (experimental), with spiral serrated wire, March, 1890.
			New cartridge case used at each fire.
26		Three wads placed between powder and shell.	Fired into field butt, section 1.
			Uncompressed copper cylinders and tables of 1890 used in rounds 2 to 4, inclusive.
25		Two wads placed between powder and shell.	Pressures taken by Lieut. W. W. Gibson, Ordnance Department.
			Firing conducted by the proof officer.

(*weight 219 pounds*), *at Sandy Hook, N. J., January 15, 1891.*

to test gun.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Time of flight.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*		*Secs.*		
No. 4, 13, 380	24	From right, 9 miles an hour.	.....	Two wads placed between powder and shell.	
No. 5, 13, 700	25		.....	Two wads placed between powder and shell.	Gun mounted on Hotchkiss mountain gun carriage.
No. 4, 16, 120	25		.....	Two wads placed between powder and shell.	Cannon friction primers (experimental), with spiral serrated wire, March, 1890.
No. 5, 14, 980	13		.....	Two wads placed between powder and shell. Recoil restrained by 2½-inch rope double, fastened to post in front of gun; rope allowed recoil of 13 feet.	Fired into field butt, section 1.
					Copper cylinders of 9,000 pounds initial compression and tables of 1887.
.....	13		.....	Three wads placed between powder and shell. Deflection 5 millimeters left. Elevation by sight on gun 60¾ millimeters; first primer failed. Shell struck 400 yards beyond and 50 yards to left of target; did not burst.	Fired at 1,000-yards target. Aimed at upper left-hand corner of screen.
.....	13		3¾	Three wads placed between powder and shell. Deflection 2½ millimeters left. Elevation by sight on gun, 28½ millimeters; first primer failed. Shell struck 18 feet to left and rear of target and burst.	Carriage standing on hard sand in front of field-gun platform.
					Fired to sea.
.....	13		4¼	Three wads placed between powder and shell. Deflection 1 millimeter left. Shell struck 275 feet in rear of target.	Cannon friction primers (experimental), with spiral serrated wire, March, 1890.
					Firing conducted by the proof officer.

Record of firing with Hotchkiss 3-inch mountain gun, No. 168 (weight

[Object of firing,

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Fuse.	Fuse set at seconds.	Elevation.	Instrumental velocity, 75 feet from muzzle.
			Oz.		*Lbs. Oz.*			° ′	*Feet.*
A. M.	12	Du Pont's I. K. H., lot 16; density, 1.725; granulation, 2,524.	13½	Hotchkiss shrapnel, lot 294.	11 5 10 fuse. 1 rifle powder, bursting charge. 12 0	Armstrong time and concussion fuse (small).	2	8 00	.....
	13		13½		11 5½ 10 fuse. 1½ rifle powder, bursting charge. 12 1		3	10 00	.....
	14		13½		11 6 10 fuse. 1½ rifle powder, bursting charge. 12 1½		4	12 00	.....

Record of firing with Hotchkiss 3-inch mountain gun, No. 168

[Object of firing, to obtain

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Instrumental velocity, —— feet from muzzle.	Pressure per square inch of bore.
A. M.			*Ounces.*		*Lbs. Oz.*	′	*Feet.*	*Pounds.*
Apr. 25	15	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	63¾	Common shell, lot 293.	11 6 10 sand. 12 0	15	Lost	.....
Apr. 25	16		63¾		11 6 10 sand. 12 0	15	Lost	.....
Apr. 25	17		63¾		11 6 10 sand. 12 0	15	Lost	.....
Apr. 25	18		13½		11 6 10 sand. 12 0	15	870 Lost. $50+\frac{75}{2}$	17,218
P. M.								
Apr. 29	19	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	13	Hotchkiss common shell, lot 293.	11 6 10 sand. 12 0	.....	.....	10,242
A. M.								
Apr. 30	20		13½		11 6 10 sand. 12 0	.....	826 826	13,901
Apr. 30	21		13½		11 7 9 sand. 12 0	15	828 824 $10+\frac{75}{2}$	14,168

219 pounds), *at Sandy Hook, N. J., January 15, 1891*—Continued.

to test gun.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Time of flight.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*		*Seconds.*		
.....	16	From right, 9 miles an hour.	4	Two wads placed between powder and shell. Shrapnel burst over water. Record of time of flight not reliable.	Fired at 1,000-yards target. Aimed at upper left-hand corner of screen.
.....	16		6¾	Three wads placed between powder and shell. Shrapnel burst over water.	Carriage standing on hard sand in front of field-gun platform. Fired to sea. Cannon friction primers (experimental), with spiral serrated wire, March, 1890.
.....	15		9	Three wads placed between powder and shell. Shrapnel burst over water.	Firing conducted by the proof officer.

(*weight 219 pounds*), *at Sandy Hook, N. J., April 25 to 30, 1891.*

velocities and pressures.]

Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.		
9	Wires of velocity targets not cut. Reduced length of copper did not come within table.	Gun mounted on Hotchkiss mountain gun carriage. Cannon friction primers, model 1887. A small piece of oakum placed over hole in brass case. Fired into field butt. Hotchkiss gauge and copper in breechblock. Hotchkiss tables used. One wad placed between powder and shell. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
9	Wires of velocity targets not cut. Reduced length of copper did not come within tables.	
9	Wires of velocity targets not cut. Reduced length of copper did not come within tables.	
19	.....	
17	Wires of second velocity target not cut ..	Gun mounted on Hotchkiss mountain gun carriage. Cannon friction primers, model 1887. Hotchkiss copper and gauge in breechblock used with Hotchkiss tables in rounds 19 to 21, inclusive. A small piece of oakum placed over hole in brass case. Fired into field butt. Uncompressed coppers used with Hotchkiss gauge in breechblock. Tables of 1890 used and reduction made for Hotchkiss piston in rounds 22 to 25, inclusive. One wad placed between powder and shell. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
20	.....	
20	.....	

Record of firing with Hotchkiss 3-inch mountain gun, No. 168

[Object of firing, to obtain

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Instrumental velocity, —— feet from muzzle.	Pressure per square inch of bore.
A. M.			*Ounces.*		*Lbs. Oz.*	′	*Feet*	*Pounds.*
May 2	22	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	7	Hotchkiss common shell, lot 293.	11 6 10 sand. 12 0	15	579 596	5,947
May 2	23				11 6 10 sand. 12 0	15	686 764	5,696
May 2	24		7		11 6 10 saad. 12 0	15	578 585 10+$\frac{5}{2}$	5,149
P. M. May 4	25		7		11 6 10 sand. 12 0	15	440 Lost. 20+$\frac{5}{2}$	5,439

Record of firing with Hotchkiss 3-inch mountain gun, No. 168

[Object of firing, to

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Pressure per square inch of bore (fuse).
			Ounces.		*Lbs. Oz.*	° ′	
May 4	26	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	7	Common shell, lot 293.	11 7 5 rifle powder, bursting charge. 11 12	50 00	Hotchkiss point percussion fuse (small).
May 4	27		7		11 7 7 rifle powder, bursting charge. 11 14	50 00	
May 5	28		7		11 7 8 rifle powder, bursting charge. 11 15	5 00	.....
May 5	29		4		11 6 10 sand. 12 0	7 00	.....

(*weight 219 pounds*), *at Sandy Hook, N. J., May 2 and 4, 1891.*

velocities and pressures.]

Recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks
Feet.		
11	Slight escape of gas through hole in brass case.	Gun mounted on Hotchkiss mountain gun carriage. Cannon friction primers, model 1887. Hotchkiss copper and gauge in breechblock used with Hotchkiss tables in rounds 19 to 21, inclusive. A small piece of oakum placed over hole in brass case. Fired into field butt. Uncompressed copper used with Hotchkiss gauge in breechblock. Tables of 1890 used and reduction made for Hotchkiss piston in rounds 22 to 25, inclusive. One wad placed between powder and shell. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, asssistant proof officer.
11	Slight escape of gas through hole in brass case.	
10	.....	
10	.....	

(*weight 219 pounds*), *at Sandy Hook, N. J., May 4 and 5, 1891.*

determine range.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Hole dug in sand for trail to give necessary elevation. Fuse made sensitive before firing. Gun turned over backwards. Shell did not burst.	Gun mounted on Hotchkiss mountain gun carriage. Cannon friction primers, model 1887. Gun carriage standing on hard sand 15 feet in front of field-gun platform; 1-inch boards placed beneath wheels of carriage. One wad placed between powder and shell. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
Hole dug in sand for trail to give necessary elevation. Fuse made sensitive before firing. Gun turned over backwards. Shell did not burst.	
Hotchkiss point percussion fuse with lead plug removed. Shell did not burst. Range, 1,754 feet; calculated muzzle velocity, 585 feet.	Gun mounted on Hotchkiss mountain gun carriage. Cannon friction primers, model 1887. Fired down the beach. One wad placed between powder and shell. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
Range, 1,318 feet; calculated muzzle velocity, 424.8 feet.	

Record of firing with Hotchkiss 3-inch mountain gun, No. 168

[Object of firing,

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Pressure per square inch of bore (fuse).
			Ounces.		*Lbs. Oz.*	° ′	
A. M. June 16	30	Laflin & Rand's I. K., lot 1; density, 1.710; granulation, 2,560.	2	Hotchkiss common shell, lot 293.	11 12 4 sand. 12 0	60 00	.....
June 16	31		3		11 12 4 sand. 12 0	60 00	.....
June 30	32		2½		11 6 10 sand. 12 0	60 00	.....
June 30	33		2½	Common shell, lot 293.	11 6 10 sand. 12 0	45 00	.....
June 30	34		2½		11 6 10 sand. 12 0	45 00	.....

Record of firing with Hotchkiss 3-inch mountain gun, No. 168

[Object of firing, to determine sensitive-

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Fuse.	Elevation.	Instrumental velocity, — feet from muzzle.
			Ounces.		*Lbs. Oz.*		° ′	*Feet.*
Sept. 30	35	Du Pont's I. K. H., lot 4; density, 1.726; granulation, 2,571.	13½	Hotchkiss shrapnel, lot 294.	11 8 10 fuse. 1 rifle powder, bursting charge. 12 3	Armstrong-Elswick time and concussion fuses.	.....	.....
Sept. 30	36		13½		11 3 10 fuse. 1½ rifle powder, bursting charge. 11 14½		.....	.....
Sept. 30	37		13½		11 4 10 fuse. 2 rifle powder, bursting charge. 12 0		.....	.....
Sept. 30	38		13½		11 4 10 fuse. 2 rifle powder, bursting charge. 12 0		.....	.....
Sept. 30	39		13½		11 4 10 fuse. 2 rifle powder, bursting charge. 12 0		.....	.....

(*weight 219 pounds*), *at Sandy Hook, N. J., June 16 and 30, 8911.*

to obtain range.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
New brass case used. Projectile observed during flight apparently steady, but projectile was horizontal in descending branch of trajectory. Measured range, 317 yards.	Gun mounted on Hotchkiss mountain gun carriage. Cannon friction primers, model 1887. Gun carriage standing on hard sand 15 feet in front of casemate; 3-inch plank placed beneath wheels of carriage. Hole dug in sand for trail to give necessary elevation. One wad placed between powder and shell. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department assistant proof officer.
Same case used as in previous round. Flight observed. Point of projectile struck ground. Gun and carriage turned over backwards. Measured range, 892 yards.	
New brass case used. Range, 541 yards	
New brass case used. Range, 477 yards	
New brass case used. The projectile was not thrown from gun, but nose protruded about 1 inch. There was a violent escape of gas through the vent. The projectile could only be removed by a sledge hammer and a copper drift inserted from the rear. The projectile calipered, when removed, 2.''98.	

(*weight 219 pounds*), *at Sandy Hook, N. J., September 30, 1891.*

ness of Armstrong-Elswick fuse.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Range.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*		*Yds.*		
.....	13	Twenty miles an hour.	.....	One wad placed between powder and shell. Burst on striking screen.	Gun mounted on Hotchkiss mountain gun carriage. Cannon friction primers, model 1887. Fired to burst on striking screen of 1-inch boards, 6 feet high and 4 feet wide, 50 feet in front of gun. New brass cases used. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
.....	14		.....	Two wads placed between powder and shell. Burst on striking screen.	
.....	10		.....	Two wads placed between powder and shell. Burst on striking screen.	
.....	9		.....	Two wads placed between powder and shell. Burst on striking screen.	
.....	7		.....	Two wads placed between powder and shell. Passed through screen, ricocheted, did not burst.	

Record of firing with Hotchkiss 3-inch mountain gun, No. 168 (weight

[Object of firing, to deter

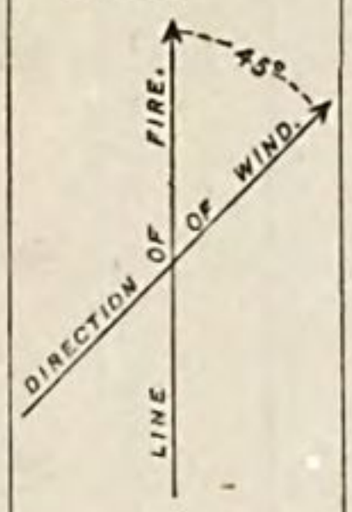
Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Fuse.	Elevation.	Instrumental velocity, — feet from muzzle.
			Ounces.		*Lbs. Oz.*		° ′	*Feet.*
Oct. 1	40	Du Pont's I. K.H., lot 4; density, 1.725; granulation, 2,571.	10	Shell, lot 293.	11 7 9 sand. 12 0	.....	45 00	.....

[Object of firing, to obtain

A. M. Dec. 18	41	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	13½	Common shell, lot 293.	11 4 12 sand. 12 0	.....	.....	{ 866 874 }
Dec. 18	42		13½		11 5 11 sand. 12 0	.....	.....	{ Lost. 859 }
Dec. 18	43		13½		11 6 10 sand. 12 0	.....	.....	{ 857 859 }
Dec. 18	44		13½		11 5 11 sand. 12 0	.....	.....	{ 841 844 }
Dec. 18	45		13½		11 4 12 sand. 12 0	.....	.....	{ 851 852 }
Dec. 18	46		7		11 4 12 sand. 12 0	.....	.....	{ 596 595 }
Dec. 18	47		7		11 5 11 sand. 12 0	.....	.....	{ 594 593 }
Dec. 18	48		7		11 6 10 sand. 12 0	.....	.....	{ 577 578 }
Dec. 18	49	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	7	Common shell, lot 293.	11 5 11 sand. 12 0	.....	.....	{ 589 589 }
Dec. 18	50		7		11 5 11 sand. 12 0	.....	.....	.....
Dec. 18	51		7		11 6 10 sand. 12 0	.....	.....	.....
Dec. 18	52		7		11 6 10 sand. 12 0	.....	.....	{ 564 563 }
								25+$\frac{59}{2}$

219 pounds), at Sandy Hook, N. J., October 1 and December 18, 1891.

mine time of flight.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Range.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*		*Yds.*		
.....	.....	Eight miles an hour. 	.....	Hole dug in sand. Rope around dead man. Boards placed under wheels. Impossible to see splash on account of waves.	Gun mounted on Hotchkiss mountain gun carriage. Carriage standing on sand in front of field-gun platform. Fired to sea. Cannon friction primers, model 1887. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer. Gun star-gauged November 5, 1891, by Lieut. C. B. Wheeler, Ordnance Department.

velocities and pressures.]

16,628	20	From rear 180°, 12 miles an hour.	.....	.....	Gun mounted on Hotchkiss mountain gun carriage. Cannon friction primers, model 1887. Fired into field butt. One wad placed between powder and shell in rounds 41 to 45, inclusive. Two wads placed between powder and shell in rounds 46 to 52, inclusive. A small piece of oakum placed over hole in brass case. Hotchkiss gauge and copper in breechblock. Hotchkiss tables used in rounds 41 to 45, inclusive. Uncompressed coppers used with Hotchkiss gauge in breechblock. Tables of 1890 used, and reduction made for Hotchkiss piston in rounds 46 to 52, inclusive. Mean velocity 5 shots, 13½ ounces, 856 feet. Mean velocity 5 shots, 7 ounces, 584 feet. Mean pressure 5 shots, 13½ ounces, 16,333 pounds. Mean pressure 6 shots, 7 ounces, 6,937 pounds. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department.
15,846	20		.....	.....	
16,553	20		.....	.....	
16,086	20		.....	.....	
16,553	20		.....	.....	
7,249	10		.....	.....	
7,145	10		.....	First primer failed.....	
6,477	10		.....	.....	
6,930	10		.....	.....	
7,016	10		.....	Case reloaded and entered chamber with difficulty.	
6,804	10		.....	First primer failed; case reloaded and entered chamber with difficulty.	
No record.	10		.....	.....	

Record of firing with Hotchkiss 3-inch mountain gun, No. 168 (weight

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Fuse.	Elevation.	Instrumental velocity, — feet from muzzle.
		Kind.	Weight.	Kind.	Weight.			
			Ounces.		*Lbs. Oz.*		° ′	*Feet.*
P. M. Dec. 18	53	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	7	Common shell, lot 293.	11 5 11 sand. 12 0	.....	20 00	.....
Dec. 18	54		7		11 6 10 sand. 12 0	.....	20 00	.....
Dec. 18	55		7		11 5 11 sand. 12 0	.....	20 00	.....
Dec. 19	56		13½		11 5 11 sand. 12 0	.....	20 00	.....
Dec. 19	57		13½		11 5 11 sand. 12 0	.....	20 00	.....
Dec. 19	58		13½		11 5 11 sand. 12 0	.....	20 00	.....

219 pounds), at Sandy Hook, N. J., December 18 and 19, 1891.

to obtain range.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Range.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Feet.*		*Yds.*		
.....	4	From right and rear 10°, 10 miles an hour.	2,020	.....	Gun mounted on Hotchkiss mountain gun carriage. Cannon friction primers, model 1887. Fired down the beach from field-gun platform. Two wads placed between powder and shell. Breechblock can not be opened when elevation is greater than 15° 15′ without again depressing piece. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
.....	4		1,993	.....	
.....	4		2,054	.....	
.....	20		3,862	Brake slipped off wheel in recoiling; case reloaded and entered chamber with difficulty.	
.....	13		3,902	Case reloaded and entered chamber with difficulty.	
.....	17		3,896	Case reloaded.....	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168

[Object of firing, to deter

Date.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation	Instrumental velocity, 75 feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.				
P. M.			*Ounces.*		*Pounds.*	*Inches.*	° ′	*Feet.*	*Pounds.*
Mar. 10	59		13		12	.....	0 05	838 844	Lost .....
Mar. 10	60		13		12	.....	0 05	862 863	Lost .....
Mar. 10	61		13		12	.....	0 10	873 874	19,113
Mar. 10	62		12½		12	.....	0 10	839 841	17,395
Mar. 10	63		12		12	.....	0 10	806 806	13,573
Mar. 10	64		12		12	.....	0 10	857 860	18,587
								50+5/2	
Mar. 11	65		12		12	.....	0 15	790 790	15,820
Mar. 11	66		11		12	.....	0 15	775 775	14,342
Mar. 11	67		11		12	.....	0 20	778 Lost.	14,865
Mar. 11	68		10½		12	.....	0 22½	744 743	13,194
Mar. 11	69		11		12	.....	0 30	758 758	13,147
								50+7.5/2	
A. M.									
Mar. 31	70		11		12	38.5125	.....	.....	14,955
Mar. 31	71		11		12	38.45	.....	.....	15,029
Mar. 31	72		11		12	38.575	.....	.....	13,591
Mar. 31	73		11		12	38.5125	.....	.....	14,865
Mar. 31	74		11		12	38.575	.....	.....	13,728
P. M.									
Mar. 31	75		11		12	38.5125	.....	.....	15,192
Mar. 31	76		11		12	38.575	.....	.....	13,804
Mar. 31	77		11		12	38.5125	.....	.....	15,087
Mar. 31	78		11		12	38.5125	.....	.....	14,257
Mar. 31	79		11		12	38.45	.....	.....	14,947

Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.

Cylindrical shot, lot 292.

(weight 219 pounds), at Sandy Hook, N. J., March 10 to 31, 1892.

mine charge of powder.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
18	From front 0°, 18 miles an hour.	Hole in cartridge case did not cover opening in breechblock containing copper cylinder.	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used. Cannon friction primers (experimental), wax stoppers, January 23, 1892. Fired from field-gun platform into field butt, No. 1. Hotchkiss gauge and copper in breechblock; Hotchkiss tables used. Powder put up in two cartridges and placed in case. Firing conducted by the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
19		Hole in cartridge case did not cover opening in breechblock containing copper cylinder.	
20		.....	
16		.....	
16		.....	
35		.....	
15	From rear and right 30°, 45 miles an hour.	.....	Gun mounted on Hotchkiss mountain gun carriage. Cannon friction primers (experimental), wax stoppers, January 23, 1892. Fired from field-gun platform into field butt, No. 1. Hotchkiss gauge and copper in breechblock; Hotchkiss tables used. Powder put up in two cartridges and placed in case with a wad on top. Firing conducted by the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
16		Before this round breechblock worked with difficulty. Block dismounted, sand cleaned from block and from recess in piece. One thread of locking screw broken. Threads in recess burred by broken thread of locking screw.	
19		.....	
15		.....	
15		Cartridge case, used in a previous round, forced in with mallet. Breechblock closed by the aid of mallet.	
19	From front and left 15°, 5 miles an hour.	Rope came off right wheel	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used. Since last firing a new locking screw was made and fitted to breechblock. Burrs removed from breechblock and from slot for block in gun. Cannon friction primers (experimental), wax stoppers, January 23, 1892. Fired into field butt. Cartridge case used in rounds 72 to 74, inclusive, was also used in rounds 75 to 79, inclusive. Firing conducted by the testing board. Present: Maj. Clifton Comly, Ordnance Department; Capt. Frank Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department.
17		Base plug of pressure gauge cracked...	
18		Rope came off right wheel	
21		Cartridge case same as used in last round. Rope came off right wheel.	
17		Cartridge case same as used in last two rounds.	
18		Rope came off right wheel	
18		.....	
15		.....	
15		.....	
15		.....	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168

[Object of firing, to test

Date.	No. of fire.	Powder.		Projectile.		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		
A. M.			*Ounces.*		*Lbs. Oz.*	*Feet.*	
Apr. 1	80	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Cylindrical shot, lot 292.	12 0	14	From front and left, 8 miles an hour.
Apr. 1	81		11		12 0	18	
Apr. 1	82		11		12 0	17	
Apr. 1	83		11		12 0	16	
Apr. 1	84		11		12 0	15	
Apr. 1	85		11		12 0	15	
Apr. 1	86		11		12 0	15	
Apr. 1	87		11		12 0	15	
Apr. 1	88		11		12 0	14	
Apr. 1	89		11		12 0	15	

[Object of firing, to test

A. M.							
Apr. 1	90	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Cylindrical shot, lot 292.	12 0	15	From front and left, 8 miles an hour,
Apr. 1	91		11		12 0	15	
Apr. 1	92		11		12 0	14	
Apr. 1	93		11		12 0	14	
Apr. 1	94		11		12 0	14	
Apr. 1	95		11		12 0	14	
Apr. 1	96		11		12 0	14	
Apr. 1	97		11		12 0	15	
Apr. 1	98		11		12 0	16	
Apr. 1	99		11		12 0	15	
Apr. 1	100		11		12 0	15	
Apr. 1	101		11		12 0	17	
Apr. 1	102		11		12 0	24	
Apr. 1	103		11		12 0	18	
Apr. 1	104		11		12 0	14	
Apr. 1	105		11		12 0	18	
Apr. 1	106		11		12 0	18	
Apr. 1	107		11		12 0	18	
Apr. 1	108		11		12 0	14	
Apr. 1	109		11		12 0	17	

[Object of firing, to test

A. M.							
Apr. 1	110	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Cylindrical shot, lot 292.	12 0	14	From front and left, 8 miles an hour.
Apr. 1	111		11		12 0	14	
Apr. 1	112		11		12 0	14	
Apr. 1	113		11		12 0	14	
Apr. 1	114		11		12 0	14	
Apr. 1	115		11		12 0	14	
Apr. 1	116		11		12 0	14	
Apr. 1	117		11		12 0	15	
Apr. 1	118		11		12 0	18	
Apr. 1	119		11		12 0	14	

(weight 219 pounds), at Sandy Hook, N. J., April 1, 1892.

gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
.....	
First primer exploded, but failed to ignite cartridge.	
.....	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used.
.....	Fired into field butt.
First primer exploded, but failed to ignite cartridge.	Cannon friction primers (experimental), wax stoppers, January 23, 1892.
.....	
Two primers exploded, but failed to ignite cartridge.	
Three primers exploded, but failed to ignite cartridge.	
.....	

gun for rapidity.]

.....	
.....	
.....	
.....	
.....	
.....	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used.
.....	New cartridge cases used.
.....	Cannon friction primers (experimental), wax stoppers, January 23, 1892.
Lashing on hook of right recoil rope broke	Lashing put over points of hooks of recoil ropes to hold them to trail handles.
Time occupied in firing 10 rounds, 7 minutes 5 seconds. Rope came off right wheel.	Piece aimed at butt at each round.
.....	Gun detachment consisted of 1 noncommissioned officer and 3 men.
Rope came off right wheel	Aimed at butt.
Rope came off right wheel	Time occupied in firing 20 rounds, 14 minutes 18 seconds.
Rope came off right wheel	
.....	
Rope came off right wheel. Two primers exploded, but failed to ignite cartridge.	
Rope came off right wheel	
.....	
.....	
Time occupied in firing 10 rounds, 7 minutes 13 seconds.	

gun for endurance.]

.....	
.....	
.....	
.....	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used,
First primer exploded, but failed to ignite cartridge.	Metallic cartridge cases used this p. m. were those used in firing this a. m., and were not resized nor cleaned. There was occasional difficulty in insertion and extraction of cartridge case, due to deformation of front end of same.
First primer exploded, but failed to ignite cartridge.	Lashing on hooks of recoil ropes renewed.
First primer exploded, but failed to ignite cartridge.	Fired into butt.
Rear edge of chamber of piece filed smooth; burrs filed from locking threads in slot for breech-block.	
First primer exploded, but failed to ignite cartridge.	
First primer exploded, but failed to ignite cartridge.	
Rope came off left wheel.	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168 (weight

[Object of firing, to test gun for rapidity

Date.	No. of fire.	Powder.		Projectile.		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		
P. M.			*Ounces.*		*Lbs. Oz.*	*Feet.*	
Apr. 1	120	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Cylindrical shot, lot 292.	12 0	14	From front and left, 8 miles an hour.
Apr. 1	121		11		12 0	15	
Apr. 1	122		11		12 0	18	
Apr. 1	123		11		12 0	15	
Apr. 1	124		11		12 0	14	
Apr. 1	125		11		12 0	15	
Apr. 1	126		11		12 0	15	
Apr. 1	127		11		12 0	15	
Apr. 1	128		11		12 0	15	
Apr. 1	129		11		12 0	15	
Apr. 1	130		11		12 0	18	
Apr. 1	131		11		12 0	15	
Apr. 1	132		11		12 0	14	
Apr. 1	133		11		12 0	14	
Apr. 1	134		11		12 0	16	
Apr. 1	135		11		12 0	15	
Apr. 1	136		11		12 0	18	
Apr. 1	137		11		12 0	16	
Apr. 1	138		11		12 0	15	
Apr. 1	139		11		12 0	14	

219 pounds), gun, at Sandy Hook, N. J., April 1, 1892—Continued.

with uncleaned cartridge cases.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used.
Rope came off left wheel.....	Cannon friction primers (experimental), wax stoppers, January 23, 1892.
Rope came off left wheel.....	Aimed at butt.
Three primers exploded, but failed to ignite cartridge.	Time occupied in firing 20 rounds, 21 minutes.
.....	Nuts loose on bolts through spokes of right wheel; wheels very shaky. Nuts tightened on both wheels after this firing.
.....	
.....	
.....	
.....	
First primer exploded, but failed to ignite cartridge. Rope came off left wheel.	
First primer exploded, but failed to ignite cartridge.	
.....	
.....	
Rope came off left wheel.....	
.....	
.....	
Three primers exploded, but failed to ignite cartridge.	
.....	
.....	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168 (weight

[Object of firing, to test

Date.	No. of fire.	Powder.		Projectile.		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		
P. M.			*Ounces.*		*Lbs. Oz.*	*Feet.*	
Apr. 1	140	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2.605.	11	Cylindrical shot, lot 292.	12 0	18	From front and left, 8 miles an hour.
Apr. 1	141		11		12 0	15	
Apr. 1	142		11		12 0	17	
Apr. 1	143		11		12 0	15	
Apr. 1	144		11		12 0	16	
Apr. 1	145		11		12 0	17	
Apr. 1	146		11		12 0	18	
Apr. 1	147		11		12 0	15	
Apr. 1	148		11		12 0	18	
Apr. 1	149		11		12 0	15	
Apr. 1	150		11		12 0	15	
Apr. 1	151		11		12 0	19	
Apr. 1	152		11		12 0	16	
Apr. 1	153		11		12 0	15	
Apr. 1	154		11		12 0	14	
Apr. 1	155		11		12 0	16	
Apr. 1	156		11		12 0	15	
Apr. 1	157		11		12 0	15	
May 19	158		11		12 0	17	
May 19	159		11		12 0	19	
May 19	160		11		12 0	17	
May 19	161		11		12 0	19	
May 19	162		11		12 0	19	
May 19	163		11		12 0	17	
May 19	164		11		12 0	19	
May 19	165		11		12 0	22	
May 19	166		11		12 0	19	
May 19	167		11		12 0	19	
May 19	168		11		12 0	20	
May 19	169		11		12 0	21	
May 19	170		11		12 0	21	
May 19	171		11		12 0	20	
May 19	172		11		12 0	21	
May 19	173		11		12 0	20	
May 19	174		11		12 0	19	
May 19	175		11		12 0	19	
May 19	176		11		12 0	18	
May 19	177		11		12 0	18	

[Object of firing, to test gun

P. M.							
May 19	178	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Cylindrical shot, lot 292.	12 0	24	From front and left, 8 miles an hour.
May 19	179		11		12 0	24	
May 19	180		11		12 0	23	
May 19	181		11		12 0	22	
May 19	182		11		12 0	23	
May 19	183		11		12 0	23	
May 19	184		11		12 0	17	
May 19	185		11		12 0	21	
May 19	186		11		12 0	20	
May 19	187		11		12 0	21	
May 19	188		11		12 0	19	
May 19	189		11		12 0	20	
May 19	190		11		12 0	19	
May 19	191		11		12 0	20	
May 19	192		11		12 0	19	
May 19	193		11		12 0	20	
May 19	194		11		12 0	19	
May 19	195		11		12 0	21	
May 19	196		11		12 0	20	
May 19	197		11		12 0	21	

219 pounds), at Sandy Hook, N. J., April 1 and May 19, 1892.

gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Rope came off left wheel	
Shot not rammed enough; knocked out and put back.	
First primer defective	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used.
Rope came off left wheel	Cannon friction primers (experimental), with wax stoppers, January 23, 1892.
First primer exploded, but failed to ignite cartridge. Rope came off left wheel.	Cartridge cases used twice previously.
Rope came off left wheel	Fired into butt.
	Firing conducted by the testing board. Present: Maj. Clifton Comly, Ordnance Department; Capt. Frank Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department.
Rope came off left wheel	
Cartridge case extracted with difficulty	
Cartridge case extractedwith difficulty	
Shot not rammed home at first attempt. It was necesssary to force the shot out and ram again.	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used. Fired into field butt No. 2. Cannon friction primers (experimental), wax stoppers, used in rounds 158 to 199, inclusive. Barometer, 29.89; thermometer, 53°; humidity, 100.

for endurance and rapidity.]

Time occupied in firing 10 rounds, 8 minutes	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used. New cartridge cases used; wax removed from vent in case. Time occupied in firing 20 rounds, 16 minutes 35 seconds.
Shot not rammed home at first attempt. It was necessary to force the shot out and ram again.	
Time occupied in firing 10 rounds, 8 minutes 35 seconds. Locking screw of breechblock burred on edge of thread; one thread broken. Thread in slot for breechblock burred.	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168

[Object of firing, to

Date.	No. of fire.	Powder.		Projectile.		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		
P. M.			*Ounces.*		*Lbs. Oz.*	*Feet.*	
May 19	198	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Cylindrical shot, lot 292.	12 0	21	----------
May 19	199		11		12 0	19	
May 19	200		11		12 0	21	
May 19	201		11		12 0	28	
May 19	202		11		12 0	27	
May 19	203		11		12 0	25	
May 19	204		11		12 0	22	
May 19	205		11		12 0	18	
May 19	206		11		12 0	20	
May 19	207		11		12 0	19	
May 19	208		11		12 0	19	
May 19	209		11		12 0	18	
May 19	210		11		12 0	18	
May 19	211		11		12 0	19	
May 19	212		11		12 0	18	
May 19	213		11		12 0	19	
May 19	214		11		12 0	20	
May 19	215		11		12 0	18	
May 19	216		11		12 0	20	
May 19	217		11		12 0	18	
May 19	218		11		12 0	18	
May 19	219		11		12 0	19	
May 19	220		11		12 0	18	
May 19	221		11		12 0	19	
May 19	222		11		12 0	19	
May 19	223		11		12 0	19	
May 19	224		11		12 0	19	
May 19	225		11		12 0	19	
May 19	226		11		12 0	19	
May 19	227		11		12 0	19	
May 19	228		11		12 0	19	
May 19	229		11		12 0	19	
May 19	230		11		12 0	23	
May 19	231		11		12 0	24	
May 19	232		11		12 0	24	
May 19	233		11		12 0	20	
May 19	234		11		12 0	20	
May 19	235		11		12 0	20	
May 19	236		11		12 0	19	
May 19	237		11		12 0	19	

[Object of firing,

A. M.							
May 25	238	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Cylindrical shot, lot 292.	12 0	14	From right and rear 65°, 8 miles an hour.
May 25	239		11		12 0	16	
May 25	240		11		12 0	17	
May 25	241		11		12 0	17	
May 25	242		11		12 0	18	
May 25	243		11		12 0	16	
May 25	244		11		12 0	19	
May 25	245		11		12 0	19	
May 25	246		11		12 0	17	
May 25	247		11		12 0	17	

(*weight 219 pounds*), *at Sandy Hook, N. J., May 19 and 25, 1892.*

test gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
.....	
.....	
Shot rammed twice before being seated at proper place in bore. Rear edge of bore burred. Cartridge case cut by burrs, rendering insertion and extraction of case difficult. Burrs at rear edge of bore removed with file.....	
.....	
One cartridge case used in the last 7 rounds, 198 to 204.	
.....	
.....	
.....	
.....	
.....	
.....	
Shot rammed twice before being seated at proper place in bore.	
.....	
.....	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used. Fired into field butt, No. 2. Cannon friction primers, model 1887, used in rounds 200 to 237, inclusive. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, in the presencce of the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
.....	
.....	
.....	
.....	
.....	
Shot rammed twice before being seated at proper place in bore. Nuts through wheel hubs tightened; some were so loose as to be easily turned by hand.	
.....	
.....	
.....	
.....	
First primer failed to ignite cartridge	
.....	
Shot rammed three times before being seated at proper place in bore. Shot rammed twice before being seated at proper place in bore. Rope came off right wheel. Lashings over points of hooks of recoil ropes broken. Shot rammed twice before being seated at proper place in bore. Rope came off left wheel.....	
.....	
.....	
Shot rammed three times before being seated at proper place in bore.	
.....	
Cartridge case used in rounds 198 to 204 used also in last 13 rounds, 225 to 237.	

test of gun.]

Two primers failed, due to moisture on inside of case, at bottom.	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used. Fired into field butt, No, 2. Cannon friction primers, model 1887. Barometer, 29.99; thermometer, 79°; humidity, 37. Firing conducted by the proof officer in the presence of the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
.....	
.....	
.....	
.....	
Breechblock could not be closed. Shot not rammed up in its seat. Shot taken out and reinstated. Case inserted with some difficulty. Had been reloaded. First shot could not be inserted..... Case withdrawn with some difficulty.....	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168 (weight

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		
A. M.			*Ounces.*		*Lbs. Oz.*	*Feet.*	
May 25	248	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Cylindrical shot, lot 292.	12 0	19	
May 25	249		11		12 0	16	
May 25	250		11		12 0	17	
May 25	251		11		12 0	17	
May 25	252		11		12 0	17	
P. M.							
May 25	253		11		12 0	16	
May 25	254		11		12 0	19	
May 25	255		11		12 0	21	
May 25	256		11		12 0	19	
May 25	257		11		12 0	17	
May 25	258		11		12 0	18	
May 25	259		11		12 0	18	
May 25	260		11		12 0	18	
May 25	261		11		12 0	19	
May 25	262		11		12 0	18	
May 25	263		11		12 0	19	
May 25	264		11	Common shell, lot 293.	11 5 *3	18	
					11 8		
A. M.							
June 2	265		11	Cylindrical shot, lot 292.	12 0	21	
June 2	266		11		12 0	20	
June 2	267		11		12 0	18	
June 2	268		11		12 0	17	
June 2	269		11		12 0	17	
June 2	270		11		12 0	18	
June 2	271		11		12 0	20	
June 2	272		11		12 0	20	
June 2	273		11		12 0	18	
June 2	274		11		12 0	20	
June 2	275		11		12 0	18	
June 2	276		11		12 0	20	
June 2	277		11		12 0	19	
June 2	278		11		12 0	20	
June 2	279		11		12 0	20	
June 2	280		11		12 0	18	
June 2	281		11		12 0	20	

* Sand.

219 pounds), at Sandy Hook, N. J., May 25 and June 2, 1892.

test of gun.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Shot inserted with difficulty after two trials. Breechblock closed with difficulty, using rammer head. Case had been reloaded.	
Case entered without difficulty. Reloaded second time.	
Same case used as in round 249. Breechblock closed with difficulty.	
Shot inserted with difficulty. Case used in seventh round could not be inserted. Another case used and inserted with slight difficulty. Shot 8 inches from breech.	
Shot 8¼ inches from breech. Case used in seventh round entered with very slight difficulty.	
Shot entered with difficulty in one position; with upper element placed at bottom entered with ease.	
Gun cleaned before this round.....	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used.
.....	Fired into field butt, No. 2.
.....	Cannon friction primers, model 1887.
.....	Barometer, 29.99; thermometer, 79°; humidity, 37.
Two projectiles could not be forced into place. Third projectile entered with ease. Action of rammer imperfect with first projectile, but not with second. Breechblock thrown to right twice before case was extracted.	
Three projectiles could not be forced in by one trial. Fourth entered. Breech block closed with some difficulty by hand. Case extracted with difficulty.	
Gun cleaned thoroughly before this round, and projectile that would not enter at previous round used. Case and projectile entered with ease. Case withdrawn with ease.	
Rejected projectile of round 259 would not enter. A projectile with front band reduced in diameter and also a new projectile entered with ease. Case entered with some difficulty. Case withdrawn with ease.	
New projectile would not enter. Gun cleaned; same projectile entered with ease. Case entered and extracted with ease.	
New projectile would not enter, two trials. Action of rammer somewhat imperfect. Second new projectile entered with ease. Case withdrawn with difficulty. Second trial of block necessary.	
Two projectiles would not enter. Shell entered with ease. Case entered with great difficulty. New case entered with ease, and withdrawn; old case used; withdrawn with ease.	
.....	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used.
.....	Cannon friction primers, model 1887.
.....	Fired into field butt, No. 2.
Cartridge case deformed. Breechblock closed with difficulty.	Barmometer, 30.24; thermometer 86°; humidity, 51.
.....	Firing conducted by the proof officer in the presence of the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
.....	
Bore wiped out with dry sponge. First cartridge case could not be inserted without difficulty. Second case inserted easily.	
.....	
.....	
.....	
.....	
.....	
.....	
First cartridge case would not permit closing of breechblock. Second case inserted easily.	
Shot not seated at proper place in bore at first attempt removed. Bore wiped with dry sponge. Shot inserted with ease.	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		
A. M.			*Ounces.*		*Lbs. Oz.*	*Feet.*	
June 2	282	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Cylindrical shot, lot 292.	12 0	20	From right and rear 65°, 8 miles an hour.
June 2	283		11		12 0	20	
June 2	284		11		12 0	19	
June 2	285		11	Rebanded	12 0	20	
June 2	286		11		12 0	20	
June 2	287		11		12 0	20	
June 2	288		11		12 0	19	
June 2	289		11	Cylindrical shot, lot 292.	12 0	21	
June 2	290		11		12 0	19	
June 2	291		11		12 0	21	
June 2	292		11		12 0	20	
June 2	293		11		12 0	20	
June 2	294		11		12 0	20	
June 2	295		11		12 0	19	
June 2	296		11		12 0	17	
June 2	297		11		12 0	19	
June 2	298		11		12 0	20	
June 2	299		11		12 0	20	
June 2	300		11		12 0	19	
June 2	301		11		12 0	20	
June 2	302		11		12 0	19	

(weight 219 pounds), at Sandy Hook, N. J., June 2, 1892.

test of gun.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powde , sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
First cartridge case would not permit closing of breechblock. Second case inserted easily.	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used. Cannon friction primers, model 1887. Fired into field butt, No. 2. Shot seat and chamber wiped out with wet sponge after each discharge from round 289 to 302, inclusive.
First cartridge case would not permit closing of breechblock. Second case entered easily. Bore cleaned with sponge. Nuts on bolts through wheel hubs tightened. One on right side and four on left side were slightly loose.	
Same cartridge case as used in last round. Case extracted with difficulty.	
Same case as used in last two rounds; inserted easily; extracted with difficulty.	
Same case as used in last three rounds. Shot not seated at proper place in bore at first attempt; rammed again. Case inserted with difficulty. Extracted with difficulty.	
Shot not seated at proper place in bore at first attempt; removed and another shot rammed. New cartridge case used.	
Cartridge case pried out	
First case would not permit closing of breechblock. Second case inserted easily.	
Same case as used in last round. Extracted with difficulty.	
Same case as used in last round. Extracted with difficulty.	
Same case as used in last round. Would not permit closing of breechblock. Second case inserted easily. Case pried out.	
New case marked No. 4 used	
Same case as used in last round. Case pried out	
Case washed on outside,	
Same case as used in last round. Washed on outside. Could not be inserted. New case marked No. 5 used.	
Case marked marked No. 5 used. Case pried out.	
Case marked No. 5 used	
Case marked No. 5 inserted with slight difficulty. Rope came off right wheel.	
Case marked No. 5 used. Case pried out	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168 (weight

[Object of firing, to test

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Time of travel of shot in bore. Flight, seconds.	Elevation.	Recoil.	Wind, strength and direction.
			Ounces.		*Lbs. Oz.*		° ′	*Feet.*	
P. M....	303	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	5½	Common shell, lot 293.	11 5 11 sand. 12 0	Lost	5 00	.....	From right and rear 65°, 8 miles an hour.
	304		5½		11 5 11 sand. 12 0	33/4	5 00	.....	
	305		5½		11 5 11 sand. 12 0	33/4	5 00	8	
	306		5½		11 5 11 sand. 12 0	3	5 00	9	
	307		5½		11 5 11 sand. 12 0	3	5 00	8	

219 pounds), at Sandy Hook, N. J., June 2, 1892—Continued.

gun for accuracy.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
.....	
.....	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used.
.....	Elevation given by quadrant.
.....	One cartridge case used in this firing.
.....	
.....	

TARGET.

Number of round.	Range.	Lateral deviation from plane of reference (right).	From center of impact, longitudinal.		From center of impact, lateral.	
			+	—	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*
303	477	1	.....	42.2	.4	.....
304	542	1	22.8	.....	.4	.....
305	494	1	.....	25.2	.4	.....
306	587	.....	67.8	.....	.....	.6
307	496	.....	.....	23.2	.....	.6
	2,596	3	90.6	90.6	1.2	1.2

2,596÷5=519.2 3÷5=.6 181.2÷5=36.24 2.4÷5=0.48

	Yards.		Yards.
Greatest range	587	Mean range	5,192
Least range	477	Mean lateral deviation from plane of fire	.6
Dispersion in range	110	Mean longitudinal deviation from center of impact	36.24
Greatest deviation from plane of fire	1	Mean lateral deviation from center of impact	0.48
Least deviation from plane of fire	0		
Lateral dispersion	1		

Record of firing with 3-inch Hotchkiss mountain gun, No. 168 (weight

[Object of firing, to test

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Time of travel of shot in bore. Flight, seconds.	Elevation.	Recoil.	Wind, strength and direction.
			Ounces.		*Lbs. Oz.*		° ′	*Feet.*	
P. M....	308	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	5½	Common shell, lot 293.	11 5 11 sand. 12 0	6	10 00	.....	From right and rear 65°, 8 miles an hour.
	309		5⅝		11 5 11 sand. 12 0	6	10 00	9	
	310		5½		11 5 11 sand. 12 0	6	10 00	8	
	311		5½		11 5 11 sand. 12 0	6	10 00	8½	
	312		5½		11 5 11 sand. 12 0	6	10 00	8	

213 pounds), at Sandy Hook, N. J., June 2, 1892—Continued.

gun for accuracy.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used.
.....	Elevation given by quadrant.
.....	The same cartridge case used as in previous 5 rounds.
.....	
Bore wiped out with wet sponge after this round.	

TARGET.

Number of rounds.	Range.	Lateral deviation from plane of reference (right).	From center of impact, longitudinal.		From center of impact, lateral.	
			+	—	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*
308	726	15	.....	149.8	.....	3.6
309	814	34	.....	61.8	.....	22.6
310	929	3	53.2	.....	8.4	.....
311	969	3	93.2	.....	8.4	.....
312	941	2	65.2	.....	9.4	.....
	4,379	57	211.6	211.6	26.2	26.2

4,379÷5=875.8 57÷5=11.4 423.2÷5=84.64 52.4÷5=10.48

	Yards.
Greatest range	969
Least range	726
Dispersion in range	243
Greatest deviation from plane of reference.	34
Least deviation from plane of reference	2
Lateral dispersion	32

	Yards.
Mean range	875.8
Mean lateral deviation from plane of reference	11.4
Mean longitudinal deviation from center of impact	84.64
Mean lateral deviation from center of impact	10.48

Record of firing with 3-inch Hotchkiss mountain gun, No. 168 (weight

[Object of firing, to test

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Time of travel of shot in bore. Flight, seconds.	Elevation.	Recoil.	Wind, strength and direction.
			Ounces.		*Lbs. Oz.*		° ′	*Feet.*	
P. M....	313	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	5½	Common shell, lot 293.	11 5 11 sand. 12 0	9	15 00	7½	From right and rear 65°, 8 miles an hour.
	314		5½		11 5 11 sand. 12 0	8¾	15 00	9	
	315		5½		11 5 11 sand. 12 0	9	15 00	7	
	316		5½		11 5 11 sand. 12 0	8½	15 00	7½	
	317		5½		11 5 11 sand. 12 0	8½	15 00	7½	

219 pounds), at Sandy Hook, N. J., June 2, 1892—Continued.

gun for accuracy.]

Special remarks, about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
Rope came off right wheel	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used. Elevation given by quadrant. The same cartridge case used as in previous 10 rounds.
.....	Gun sighted by Lieut. O. M. Lissak, Ordnance Department. Target observed by Corpl. Burt, Ordnance Detachment.
.....	Firing conducted by Lieut. O. M. Lissak, Ordnance Department, in presence of the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Depart-partment; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
.....	

TARGET.

Number of round.	Range.	Lateral deviation from plane of reference (left).	From center of impact, longitudinal.		From center of impact, lateral.	
			+	−	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*
313	1,346	2	2.6	.....	.....	.8
314	1,446	4	102.6	.....	1.2	.....
315	1,346	4	2.6	.....	1.2	.....
316	1,322	3	.....	21.4	.2	.....
317	1,257	1	.....	86.4	.....	1.8
	6,717	14	107.8	107.8	2.6	2.6

6,717÷5=1,343.4 14÷5=2.8 215.6÷5=43.12 5.2÷5=1.04

	Yards.		
Greatest range	1,446	Mean range	1,343.4
Least range	1,257	Mean lateral deviation from plane of reference	2.8
Dispersion in range	189	Mean longitudinal deviation from center of impact	43.12
Greatest deviation from plane of reference	4	Mean lateral deviation from center of impact	1.04
Least deviation from plane of reference ..	1		
Lateral dispersion	3		

Record of firing with 3-inch Hotchkiss mountain gun, No. 168

[Object of firing,

	No. of fire.	Powder.		Projectile.		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		
			Ounces.		*Lbs.*	*Feet.*	
A. M	318	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Cylindrical shot, lot 292.	12	20	From front and left 35°, 10 miles an hour.
	319		11		12	19	
	320		11		12	20	
	321		11		12	20	
	322		11		12	19	
	323		11		12	19	
	324		11		12	20	
	325		11		12	20	
	326		11		12	19	
	327		11		12	20	
	328		11		12	20	
	329		11		12	19	
	330		11		12	19	
	331		11		12	19	
	332		11		12	21	
	333		11		12	.....	
	334		11		12	20	
	335		11		12	20	
	336		11		12	20	
	337		11		12	20	
	338		11		12	20	
	339		11		12	20	
	340		11		12	20	
	341		11		12	20	
	342		11		12	20	
	343		11		12	20	
	344		11		12	20	
	345		11		12	20	
	346		11		12	20	
	347		11		12	20	
	348		11		12	20	
	349		11		12	20	
	350		11		12	20	
	351		11		12	20	
	352		11		12	20	
	353		11		12	20	
	354		11		12	20	
	355		11		12	20	
	356		11		12	20	
	357		11		12	20	
	358		11		12	20	
	359		11		12	20	
	360		11		12	20	
	361		11		12	20	
	362		11		12	20	

(*weight 219 pounds*), *at Sandy Hook, N. J., June 3, 1892.*

test of gun.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Case inserted with difficulty. First primer exploded, but failed to ignite charge	
.....	
.....	
Chisel used to extract case.....	
Chisel used to extract case	
Shot not forced home at first attempt; had to be rammed out. Chamber sponged; shot entered easily.	
Case inserted with difficulty.....	
Case inserted with difficulty.....	
Chamber sponged out; chisel used to extract case.	
Chamber sponged out; chisel used to extract case.	
Case inserted with difficulty. Extracted easily..	
Chisel used to extract case.....	
Case inserted with difficulty; rammer against breechblock.	
Case inserted with difficulty; rammer against breechblock.	
Chisel used to extract case	
.....	
Case inserted with difficulty; rammer against breechblock.	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used.
.....	Cannon friction primers, model 1887; Frankford Arsenal, January, 1891.
Chisel used to extract case.....	Fired into field butt, No. 2.
Case inserted with difficulty.....	Chamber sponged out after each round, beginning with round 326.
Case inserted with difficulty. Chisel used to extract case.	Barometer, 30.22; thermometer, 74°; humidity, 78.
.....	Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, in the presence of the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
Case inserted with difficulty; rammer against breechblock.	
Case inserted with difficulty.....	
Case inserted with difficulty; rammer against breechblock. Chisel used to extract case.	
Breechblock worked hard; cleaned and oiled. Case used was badly jammed in front; could not be inserted; another case used.	
.....	
Breechblock oiled. Chisel used to extract case..	
.....	
Case inserted with difficulty; rammer against breechblock. Chisel used to extract case.	
Breechblock oiled. Chisel used to extract case..	
.....	
.....	
.....	
Chisel used to extract case.....	
Case inserted with slight difficulty. Chisel used to extract case.	
.....	
Chisel used to extract case.....	
Breechblock oiled.....	
Breechblock oiled.....	
Case inserted with slight difficulty	
.....	
Case inserted with slight difficulty; end crimped.	
Breechblock oiled.....	
Chisel used to extract case.....	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168 (weight

[Object of firing, to

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Deflection (points right).	Recoil.	Wind, strength and direction.
			Ounces.		*Pounds.*	° ′		*Feet.*	
P. M.	363	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Shell, lot 293; weighted up with sand.	12	6 00	1	18	From front and left 35°, 10 miles an hour.
	364		11		12	5 00	1	18	
	365		11		12	4 30	3	19	
	366		11		12	4 40	3	19	
	367		11		12	4 40	3	19	
	368		11		12	4 40	3	19	
	369		11		12	4 40	3	19	
	370		11		12	4 40	3	20	
	371		11		12	4 35	2	19	
	372		11		12	4 30	2	20	
	373		11		12	4 35	2	19	
	374		11		12	4 32	2	20	

[Object of firing, to

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Deflection (points right).	Recoil.	Wind, strength and direction.
			Ounces.		*Pounds.*	° ′		*Feet.*	
P. M.	375	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Shell, lot 293; weighted up with sand.	12	4 34	2	19	From front and left 35°, 10 miles an hour.
	376		11		12	4 34	2	19	
	377		11		12	4 34	2	19	
	378		11		12	4 34	2	19	
	379		11		12	4 34	2	19	
	380		11		12	4 34	2	19	
	381		11		12	4 34	2	20	
	382		11		12	4 34	2	19	
	383		11		12	4 34	2	19	
	384		11		12	4 34	2	19	

219 pounds), at Sandy Hook, N. J., June 3, 1892—Continued.

test gun for accuracy.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Sighting shot. Struck about 300 yards in rear of target.	
Sighting shot. Struck about 200 yards in rear of target.	
Sighting shot. Struck target 1 foot below and 10½ feet right of center.	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes.
Struck target 4 feet above and 9 feet right of center..	Cannon friction primers, model 1887; Frankford Arsenal, January, 1891.
Miss. Struck about 200 yards in rear of target	Fired from fort wall at 1,000-yards target. Aimed at upper left edge.
Miss. Struck about 150 yards in rear of target	
Struck target 7 feet above and 10 feet right of center.	Elevation given by quadrant.
Miss. Struck about 65 yards in rear of target.....	Barometer, 30.22; thermometer, 74°; humidity, 78.
Shot not seated at first attempt. Removed chamber, sponged out; shot entered easily. Miss. Struck 80 yards in rear of target.	
Miss. Struck 9 yards in front of target.....	
Struck target 7½ feet above and 2½ feet left of center..	
Struck 4 feet in front of target and ricocheted through.	

test gun for accuracy.]

From center of target.				From center of impact.				Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc,, and metrological data.	General remarks.
Vertical.		Horizontal.		Vertical.		Horizontal.			
Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.		
2	....	2	.....	4.429	.....	1.071	.....	French quadrant used, beginning with round 375.	Cannon friction primers, model 1887; Frankford Arsenal, January, 1891. Fired from fort wall at 1,000-yards target. Aimed at the upper left edge.
....	5	2	.....	.....	2.571	1.071	.....	.....	Feet.
....	7	.....	.....	.....	4.571	.....	.929	.....	Center of impact, right ..... 0.929 Center of impact, below..... 2.429
....	....	.....	.....	.....	.....	.....	.....	Miss. Struck 40 yards in front of target.	Mean vertical deviation from center of impact .... 4.94 Mean horizontal deviation from center of impact. 1.08
....	....	.....	.....	.....	.....	.....	.....	Miss. Struck 125 yards in rear of target.	Mean deviation from center of impact..... 5.056
....	6	2.5	.....	.....	3.571	1.571	.....	.....	Gun sighted by Lieut. C. B. Wheeler, Ordnance Department. Target observed by Sergt. Freeman, Ordnance Detachment.
....	9	.....	.....	.....	6.571	.....	.929	.....	Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, in the presence of the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
....	....	.....	.....	.....	.....	.....	.....	Miss. Struck 23 feet in front of target.	
5	....	.....	1	7.429	.....	.....	1.929	.....	
3	....	1	.....	5.429	.....	.071	.....	.....	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168

[Object of firing, to

	No. of fire.	Powder.		Projectile.		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		
			Ounces.		*Pounds.*	*Feet.*	
A. M	385	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Cylindrical shot, lot 292.	12	16	From right and rear, 8 miles an hour.
	386		11		12	18	
	387		11		12	18	
	388		11		12	19	
	389		11		12	19	
	390		11		12	19	
	391		11		12	19	
	392		11		12	18	
	393		11		12	17	
	394		11		12	19	
	395		11		12	18	
	396		11		12	18	
	397		11		12	18	
	398		11		12	19	
	399		11		12	19	
	400		11		12	20	
	401		11		12	20	
	402		11		12	19	
	403		11		12	19	
	404		11		12	18	
	405		11		12	19	
	406		11	Cylindrical shot, rebanded.	12	20	
	407		11		12	18	
	408		11		12	19	
	409		11		12	19	
	410		11		12	19	
	411		11		12	19	
	412		11		12	19	
	413		11		12	20	
	414		11		12	19	
	415		11		12	19	
	416		11		12	20	
	417		11		12	20	
	418		11		12	19	
	419		11		12	19	
	420		11		12	20	
	421		11		12	19	
	422		11		12	20	
	423		11		12	20	
	424		11		12	19	

(*weight 219 pounds*), *at Sandy Hook, N. J., June 6, 1892.*

test gun for endurance.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used. Cases used previously. Chamber and shot seat sponged before each round. Cannon friction primers, model 1887. Fired into field butt, No. 2. Barometer, 30.14; thermometer, 82°; humidity, 62. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, in presence of testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
.....	
Case pried out.....	
.....	
Case pried out.....	
Case pried out.....	
Case pried out.....	
Case pried out.....	
Case pried out.....	
Case pried out.....	
First case could not be inserted; second case inserted easily.	
.....	
First primer failed to ignite charge.....	
First case could not be inserted; second case inserted easily. Case pried out.	
.....	
.....	
.....	
Case pried out.....	
.....	
.....	
.....	
.....	
First case could not be inserted; second case inserted easily. Case pried out.	
.....	
.....	
.....	
.....	
.....	
.....	
Case pried out.....	
Case pried out.....	
Case pried out.....	
.....	
.....	
.....	
.....	
Case pried out.....	
Case pried out.....	
First case could not be inserted; second case inserted with difficulty.	
.....	
Case pried out.....	
.....	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168 (weight

[Object of firing, to test

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore (deflection points).		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		Right.	Left.		
P. M.			*Ounces.*		*Lbs. Oz.*	° ′	*Pounds.*	*Pounds.*	*Feet.*	
June 6	425		11		11 5 11 sand. 12 0	9 00	1	.....	19	
June 6	426		11		11 5 11 sand. 12 0	8 20	1	.....	20	
June 6	427		11		11 5 11 sand. 12 0	8 33	½	.....	19	
June 6	428		11		11 5 11 sand. 12 0	8 26	½	.....	.....	
June 6	429		11		11 5 11 sand. 12 0	8 28	½	.....	.....	
June 6	430		11		11 5 11 sand. 12 0	8 30	¼	.....	.....	
June 6	431		11		11 5 11 sand. 12 0	8 30	¼	.....	.....	
June 6	432		11		11 5 11 sand. 12 0	8 30	¼	.....	20	
June 6	433		11		11 5 11 sand. 12 0	8 31	¼	.....	19	
June 6	434		11		11 5 11 sand. 12 0	8 31	¼	.....	20	
June 6	435		11		11 5 11 sand. 12 0	8 31	¼	.....	19	
June 6	436		11		11 5 11 sand. 12 0	8 31	¼	.....	20	
June 6	437		11		11 11 3 sand. 11 14	8 46	.....	.....	20	
June 6	438		11		11 10 3 sand. 11 13	8 44	.....	.....	20	

Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.

Common shell, lot 293.

Cast-iron shrapnel, lot 294.

From right and rear 15°, 8 miles an hour.

219 pounds), at Sandy Hook, N. J., June 6, 1892—Continued.

gun for accuracy.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Three primers exploded, but failed to ignite charge. Case removed; another inserted. Three primers exploded; also failed to ignite charge. Case removed; another case used. One primer failed to ignite charge. Case again removed; new case used. Shot struck 100 yards beyond target.	
Struck 60 yards in front and 8 yards to right of target.	
Struck 100 yards in rear of target	
Struck 60 feet in front and 16 feet to right of target.	
Struck 60 feet in front and 20 feet to right of target.	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used.
Struck 7 feet below and 9 feet to right of center of target.	Cannon friction primers, model 1887; Frankford Arsenal, January 1891.
Struck 100 feet in front and 18 feet to right of center of target.	Fired at 1-mile target.
Struck 18 feet in front and 5 feet to right of center of target.	Fired from fort wall. Aimed at left edge of target.
Case removed with difficulty. Shot struck center of bull's-eye.	French quadrant used.
Struck the ground 75 yards in rear of target	The cases used in first round had been washed out and not properly dried. When this was done the difficulty in igniting charge was overcome. It is also quite possible that the perforated disk in bottom of case was pressed back on base so as not to permit of a sufficient passage for flame from primer. The disks were all pushed forward.
Struck 180 feet beyond target	Barometer, 30.11; thermometer, 82°; humidity, 55.
Struck target 9 feet above center	Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, in the presence of the testing board. Present: Capt. F. Heath and Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
Sighting shot. Two primers failed to ignite charge (case not properly dried). Case removed; new case used. Shot struck 100 yards beyond target.	
Sighting shot. Struck 75 yards beyond target.	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168

[Object of firing,

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore (deflection points).		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		Right.	Left.		
A. M.			*Ounces.*		*Lbs. Oz.*	° ′	*Pounds.*	*Pounds.*	*Feet.*	
June 9	439	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Cylindrical shot, rebanded.	12 0	.....	.....	.....	30	From left and rear 15°, 4 miles an hour.
June 9	440		11		12 0	.....	.....	.....	21	
June 9	441		11		12 0	.....	.....	.....	20	
June 9	442		11		12 0	.....	.....	.....	20	
June 9	443		11		12 0	.....	.....	.....	16	
June 9	444		11		12 0	.....	.....	.....	16	
June 9	445		11		12 0	.....	.....	.....	15	
June 9	446		11		12 0	.....	.....	.....	18	
June 9	447		11		12 0	.....	.....	.....	16	
June 9	448		11		12 0	.....	.....	.....	15	
June 9	449		11		12 0	.....	.....	.....	15	
June 9	450		11		12 0	.....	.....	.....	18	
June 9	451		11		12 0	.....	.....	.....	17	
June 9	452		11		12 0	.....	.....	.....	15	
June 9	453		11		12 0	.....	.....	.....	18	
June 9	454		11		12 0	.....	.....	.....	15	
June 9	455		11		12 0	.....	.....	.....	19	
June 9	456		11		12 0	.....	.....	.....	16	
June 9	457		11		12 0	.....	.....	.....	15	
June 9	458		11		12 0	.....	.....	.....	16	
June 9	459		11		12 0	.....	.....	.....	15	
June 9	460		11		12 0	.....	.....	.....	16	
June 9	461		11		12 0	.....	.....	.....	17	
June 9	462		11		12 0	.....	.....	.....	18	
June 9	463		11		12 0	.....	.....	.....	18	
June 9	464		11		12 0	.....	.....	.....	18	
June 9	465		11		12 0	.....	.....	.....	18	
June 9	466		11		12 0	.....	.....	.....	19	
June 9	467		11		12 0	.....	.....	.....	18	
June 9	468		11		12 0	.....	.....	.....	18	
June 9	469		11		12 0	.....	.....	.....	20	
June 9	470		11		12 0	.....	.....	.....	18	

(*weight 219 pounds*), *at Sandy Hook, N. J., June 9, 1892.*

test of gun.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Old case used. Two primers failed to ignite cartridge. New case then used and cartridge ignited by first primer. Old case extracted with difficulty; new case easily. Recoil due to wet platform.	
Case inserted with difficulty; case extracted with difficulty.	
Rope came off left wheel. Case extracted with difficulty.	
Case inserted with slight difficulty; extracted with difficulty.	Gun mounted on Hotchkiss mountain gun carriage. Rope brakes used.
Case inserted with difficulty; extracted with difficulty.	Sand placed on platform after first round.
Case extracted with difficulty	Gun sponged out before each round.
Case inserted with difficulty; extracted with difficulty.	Fired into field butt, No. 2; butt repaired since last firing.
Case inserted with slight difficulty; extracted with difficulty.	The same cartridge case used in rounds 439 to 452, inclusive.
Case inserted with great difficulty; rammer head used on breechblock; extracted with difficulty.	Cannon friction primers, model 1887; Frankford Arsenal, January, 1891.
New case used; inserted with ease; extracted with ease.	The same cartridge case used in rounds 453 to 463, inclusive.
Rope came off left wheel	The same cartridge case used in rounds 464 to 470, inclusive.
Case extracted with difficulty	Barometer, 30.05; thermometer, 70°; humidity, 77.
Case extracted with slight difficulty	Firing conducted by the proof officer in the presence of the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department, of board for testing rifled cannon.
Case extracted with difficulty	
Case extracted with difficulty	
New case used; inserted with ease; extracted with ease.	
Shot could not be seated at proper place in bore; removed and another shot rammed.	
Case extracted with difficulty	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168

[Object of firing, to test

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore (deflection points).		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		Right.	Left.		
A. M.			*Ounces.*		*Lbs. Oz.*	° ′	*Pounds.*	*Pounds.*	*Feet.*	
June 10	471	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Shrapnel, lot 294, with blunt lead plugs.	11 11 3 sand. 11 14	11 00	.....	.....	.....	From front, 6 miles an hour.
June 10	472		11		11 10 3 sand. 11 13	11 00	.....	.....	.....	
June 10	473		11		11 9 3 sand. 11 12	11 00	.....	.....	.....	
June 10	474		11		11 10 3 sand. 11 13	11 00	.....	.....	.....	
June 10	475		11		11 10 3 sand. 11 13	11 00	.....	.....	.....	

(*weight 219 pounds*), *at Sandy Hook, N. J., June 10, 1892.*

gun for accuracy.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	Gun mounted on Hotchkiss mountain gun carriage.
.....	New cases used.
.....	Fired down the beach. Aimed at second post from left in old butt.
.....	Gun sponged out after each round.
Chisel used to extract case	Elevating screw runs down after each discharge. Barometer, 30.05; thermometer, 63°; humidity, 64
Case extracted with some difficulty. Whistling noise observed in air after this round.....	

TARGET.

Number of round.	Range.	Lateral deviation from plane of reference (right).	From center of impact, longitudinal		From center of impact, lateral.	
			+	—	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*
471	2,166	44	.....	51.8	.....	6.2
472	2,264	51	46.2	.....	.8	.....
473	2,281	55	63.2	.....	4.8	.....
474	2,249	49	31.2	.....	.....	1.2
475	2,129	52	.....	88.8	1.8	.....
	11,089	251	140.6	140.6	7.4	7.4

11,089÷5=2,217.8 251÷5=50.2 281.2÷5=56.24 14.8÷5=2.96

	Yards.
Greatest range	2,281
Least range	2,129
Dispersion in range	152
Greatest deviation from plane of reference	55
Least deviation from plane of reference	44
Lateral dispersion	11

	Yards.
Mean range	2217.8
Mean lateral deviation from plane of reference	50.2
Mean longitudinal deviation from center of impact	56.24
Mean lateral deviation from center of impact	2.96

Record of firing with 3-inch Hotchkiss mountain gun, No. 168 (weight

[Object of firing, to test

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore (deflection points).		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		Right.	Left.		
A. M.			*Ounces.*		*Lbs. Oz.*	° ′	*Pounds.*	*Pounds.*	*Feet.*	
June 10	476	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Shrapnel, lot 294, with blunt lead plugs.	11 11 3 sand. 11 14	14 00	.....	3	.....	From front, 6 miles an hour.
P. M.										
June 10	477		11		11 11 3 sand. 11 14	14 00	.....	3	12	
June 10	478		11		11 9 3 sand. 11 12	14 00	.....	3	10	
June 10	479		11		11 10 3 sand. 11 13	14 00	.....	3	11	
June 10	480		11		11 10 3 sand. 11 13	14 00	.....	3	10	
June 10	481		11		11 9 3 sand. 11 12	14 00	.....	3	10	

219 pounds), *at Sandy Hook, N. J., June 10, 1892*—Continued.

gun for accuracy.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Chisel used to extract case	Gun mounted on Hotchkiss mountain gun carriage. Fired down the beach.
Wheel of carriage struck projection on platform and piece and carriage turned over.	
Cartridge case pried out	
Cartridge case pried out	
In recoiling carriage struck projection on platform and turned over on right side.	
Cartridge case pried out	

TARGET.

Number of round.	Range.	Lateral deviation from plane of reference (right).	From center of impact, longitudinal.		From center of impact, lateral.	
			+	−	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*
477	2,583	185	.....	52.4	20.4	.....
478	2,633	157	.....	2.4	.....	7.6
479	2,662	153	26.6	.....	.....	11.6
480	2,667	167	31.6	.....	2.4	.....
481	2,632	161	.....	3.4	.....	3.6
	13,177	823	58.2	58.2	22.8	22.8

13,177÷5=2,635.4 823÷5=164.6 116.4÷5=23.28 45.6÷5=9.12.

	Yards.
Greatest range	266
Least range	2,583
Dispersion in range	84
Greatest deviation from plane of reference	185
Least deviation from plane of reference	153
Lateral dispersion	32

	Yards
Mean range	2,635.4
Mean lateral deviation from plane of reference	164.6
Mean longitudinal deviation from center of impact	23.28
Mean lateral deviation from center of impact	9.12

Record of firing with 3-inch Hotchkiss mountain gun, No. 168

[Object of firing, to test

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore (deflection points).		Recoil.	Wind, strength and direction.
		Kind.	Weight.	Kind.	Weight.		Right.	Left.		
P. M.			*Ounces.*		*Lbs. Oz.*	° ′	*Pounds.*	*Pounds.*	*Feet.*	
June 10	482		11		11 11 3 sand. 11 14	17 00	.....	.....	10	
June 10	483		11		11 11 3 sand. 11 14	17 00	4	.....	10	
June 10	484		11		11 9 3 sand. 11 12	17 00	4	.....	10	
June 10	485		11		11 9 3 sand. 11 12	17 00	6	.....	11	
June 10	486		11		11 11 3 sand. 11 14	17 00	9½	.....	11	
June 10	487		11		11 9 3 sand. 11 12	17 00	12½	.....	11	.....
June 10	488		11		11 8 3 sand. 11 11	17 00	12½	.....	10	
June 10	489	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Shrapnel, lot 294, with blunt lead plugs.	11 10 3 sand. 11 13	17 00	15	.....	10	
A. M. June 11	490		11		11 11 3 sand. 11 14	17 00	.....	18	11	
June 11	491		11		11 9 3 sand. 11 12	17 00	.....	18	11	
June 11	492		11		11 10 3 sand. 11 13	17 00	.....	18	11	
June 11	493		11		11 9 3 sand. 11 12	17 00	.....	15	9	From front at right 20°, 8 miles an hour.
June 11	494		11		11 11 3 sand. 11 14	17 00	.....	15	12	
June 11	495		11		11 11 3 sand. 11 14	17 00	.....	15	10	

(weight 219 pounds), at Sandy Hook, N. J., June 10 and 11, 1892.

gun for accuracy.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
.....	
.....	
First primer exploded, but failed to ignite charge. Wheel struck projection on platform and carriage turned over on right side. Case pried out.	
Case pried out.....	
.....	
Case pried out.....	
Shot not seated at first ramming; forced out and rammed again.	
.....	
.....	
.....	
Rope came off both wheels.....	
First primer failed to ignite charge.....	
First primer failed to ignite charge.....	Aimed at left edge of 3,000-yards target.
.....	

Record of firing with 3-inch Hotchkiss mountain gun, No. 168

[Object of firing, to test

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore (deflection points).		Recoil.	Wind, strength and direction
		Kind.	Weight.	Kind.	Weight.		Right.	Left.		
P. M.			*Ounces.*		*Lbs. Oz.*	° ′	*Pounds.*	*Pounds.*	*Feet.*	
June 11	496	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Shrapnel, lot 294, with blunt lead plugs.	11 9 3 sand. 11 12	17 00	.....	15	12	From front and right 20°, 8 miles an hour.
June 11	497		11		11 10 3 sand. 11 13	17 00	.....	15	12	
June 11	498		11		11 10 3 sand. 11 13	17 00	.....	15	14	

(weight 219 pounds), at Sandy Hook, N. J., June 11, 1892.

gun for accuracy.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Rope on left wheel came off. Carriage turned over on right side. Cartridge case pried out.	Aimed at left edge of 3,000-yards target.
.....	
Rope came off right wheel.....	

TARGET.

Number of round.	Range.	Lateral deviation from plane of reference (right).	From center of impact, longitudinal.		From center of impact, lateral.	
			+	—	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*
493	3,049	29	.....	5.8	8.4	.....
494	3,025	29	.....	29.8	8.4	.....
495	3,020	13	.....	34.8	.....	7.6
496	3,100	6	45.2	.....	.....	14.6
498	3,080	26	25.2	.....	5.4	.....
	15,274	103	70.4	70.4	22.2	22.2

15,274÷5=3,054.8 103÷5=20.6 140.8÷5=28.16 44.4÷5=8.88

	Yards.
Greatest range	3,100
Least range	3,020
Dispersion in range	80
Greatest deviation from plane of reference	29
Least deviation from plane of reference	6
Lateral dispersion	23

	Yards.
Mean range	3,054.8
Mean lateral deviation from plane of reference	20.6
Mean longitudinal deviation from center of impact	28.16
Mean lateral deviation from center of impact	8.88

Record of firing with 3-inch Hotchkiss mountain gun, No. 168 (weight

[Object of firing, to test

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Pressure per square inch of bore (deflection points).		Recoil.	Wind, strength and direction.
		Kind.	Weight	Kind.	Weight.		Right.	Left.		
A. M.			*Ounces.*		*Lbs. Oz.*	° ′	*Pounds.*	*Pounds.*	*Feet.*	
June 11	499	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2,605.	11	Shrapnel, lot 294, with blunt lead plugs.	11 10 3 sand. 11 13	20 00	.....	.....	14	From front and right 20°, 8 miles an hour.
June 11	500		11		11 10 3 sand. 11 13	20 00	.....	8	11	
June 11	501		11		11 9 3 sand. 11 12	20 00	.....	5	10	
June 11	502		11		11 9 3 sand. 11 12	20 00	.....	.....	12	
June 11	503		11		11 9 3 sand. 11 12	20 00	.....	.....	11	
June 11	504		11		11 9 3 sand. 11 12	20 00	.....	.....	22	
June 11	505		11		11 8 3 sand. 11 11	20 00	.....	.....	11	

219 pounds), at Sandy Hook, N. J., June 11, 1892—Continued.

gun for accuracy.]

Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Rope came off left wheel	Gun sighted by Lieut. O. M. Lissak, Ordnance Department. Target observed by Sergt. Freeman, Ordnance Detachment. Firing conducted by Lieut. O. M. Lissak, Ordnance Department. in the presence of the testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
First primer failed to ignite charge; cartridge case pried out.	
Rope came off right wheel	
Rope came off both wheels	
Cartridge case pried out	

TARGET.

Number of round.	Range.	Lateral deviation from plane of reference.		From center of impact, longitudinal.		From center of impact, lateral.	
		Right.	Left.	+	−	Right.	Left.
	Yards.	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*	*Yards.*
501	3,316	30	.....	.....	94.4	13.6	.....
502	3,432	2	.....	21.6	.....	.....	14.4
503	3,307	40	.....	.....	103.4	23.6	.....
504	3,478	.....	10	67.6	.....	.....	26.4
505	3,519	20	.....	108.6	.....	3.6	.....
	17,052	92	10	197.8	197.8	40.8	40.8

17,052÷5=3,410.4 92—10=82÷5=16.4 395.6÷5=79.12 81.6÷5=16.32

	Yards.		Yards.
Greatest range	3,519	Mean range	3,410.4
Least range	3,307	Mean lateral deviation from plane of reference	16.4
Dispersion in range	212	Mean longitudinal deviation from center of impact	79.12
Greatest deviation from plane of reference, right	40	Mean lateral deviation from center of impact	16.32
Greatest deviation from plane of reference, left	10		
Lateral dispersion	50		

TARGET RECORD OF 3" Hotchkiss Mountain Gun

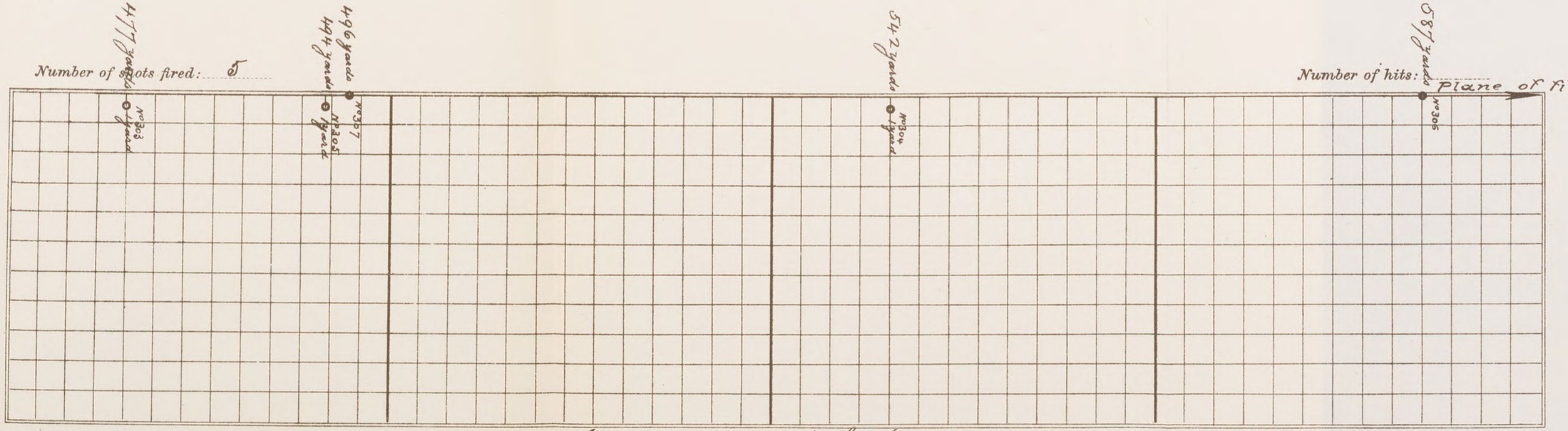
AT SANDY HOOK, N. J. June 2d 1892

Charge of Powder 5½ ozs.
Elevation 5°

Target ..... from Gun.

Number of shots fired: 5

Number of hits: Plane of fire



Target 11' × 52'.

Scale 2½ yards to the Square

Gun sighted by Lieut. O. M. Lissak, Ord. Dept.
Fall of projectile observed by Corp. Burt. Ord. Det

Wind 8 *miles per hour.*

Appendix 41, 1892.

Ormond M. Lissak
Lieut. Ord. Dept.

TARGET RECORD OF

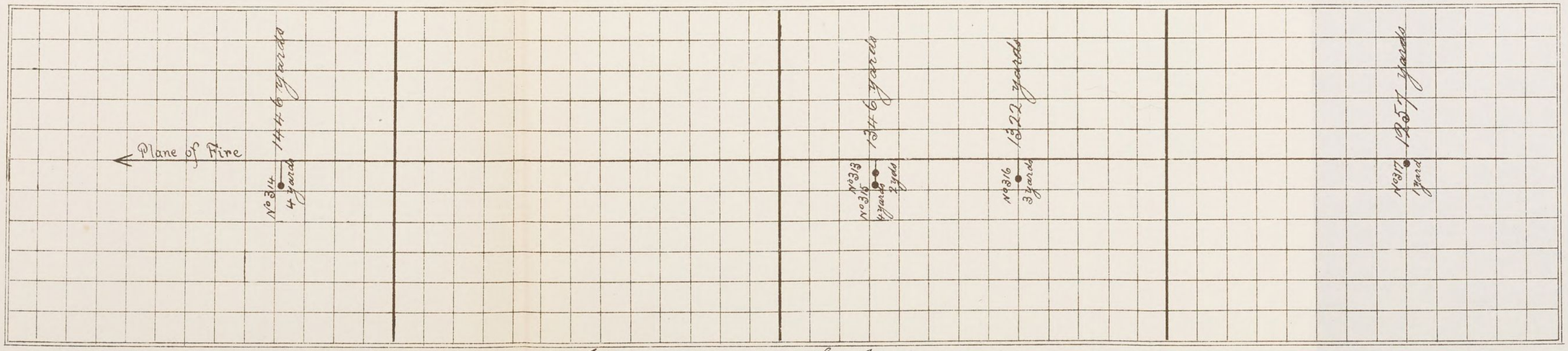
TARGET RECORD OF 3" Hotchkiss Mountain Gun

Charge of Powder 5½ ozs
Elevation 15°

AT SANDY HOOK, N. J. June 2nd 1892

Target ..... from Gun.

Number of shots fired: 5 *Number of hits:* .....



Target 11' × 52'.

Scale 5 yards to the Square

Gun sighted by Lieut. O. M. Lissak Ord. Dept.
Fall of projectile observed by Corp. Burt. Ord. Det.

Omond M. Lissak
Lieut. Ord. Dept.

Wind 8 *miles per hour.*

Appendix 41, 1892.

TARGET RECORD OF

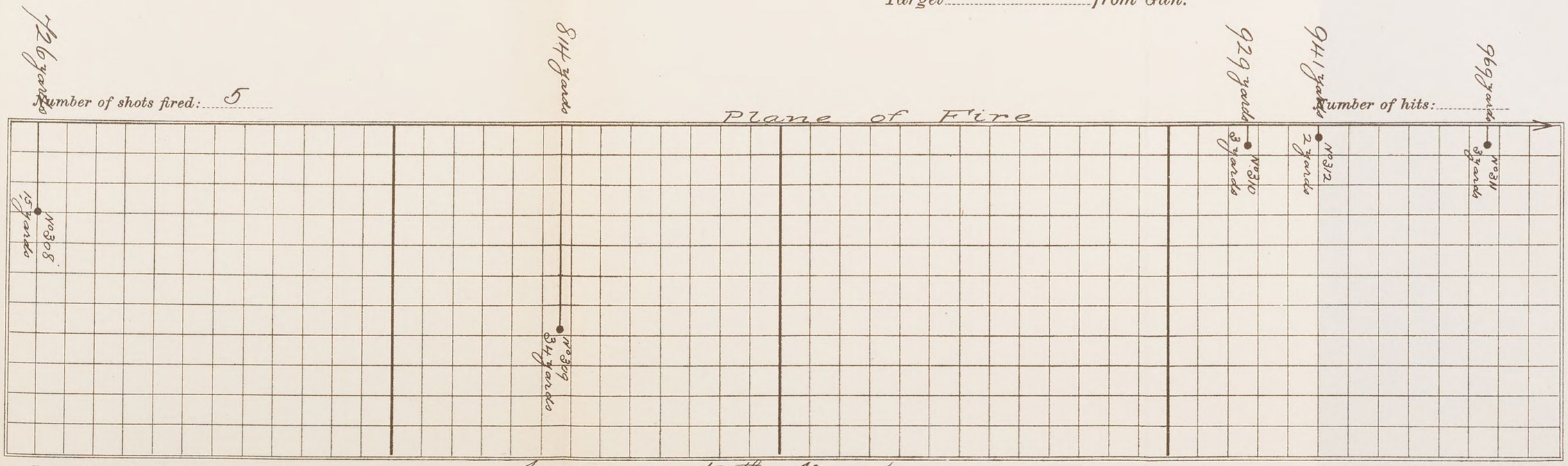
Plane of Fire →

TARGET RECORD OF 3" Hotchkiss Mountain Gun.

Charge of Powder 5½ ozs.
Elevation 10°

AT SANDY HOOK, N. J. June 2nd 1892.

Target ..... from Gun.



Number of shots fired: 5

Number of hits: .....

Target 11′ × 52′.

Scale 5 yards to the Square.

Gun sighted by Lieut. O. M. Lissak, Ord. Dept.
Fall of projectile observed by Corp. Burt, Ord. Det.

Wind 8 *miles per hour.*

Appendix 41, 1892.

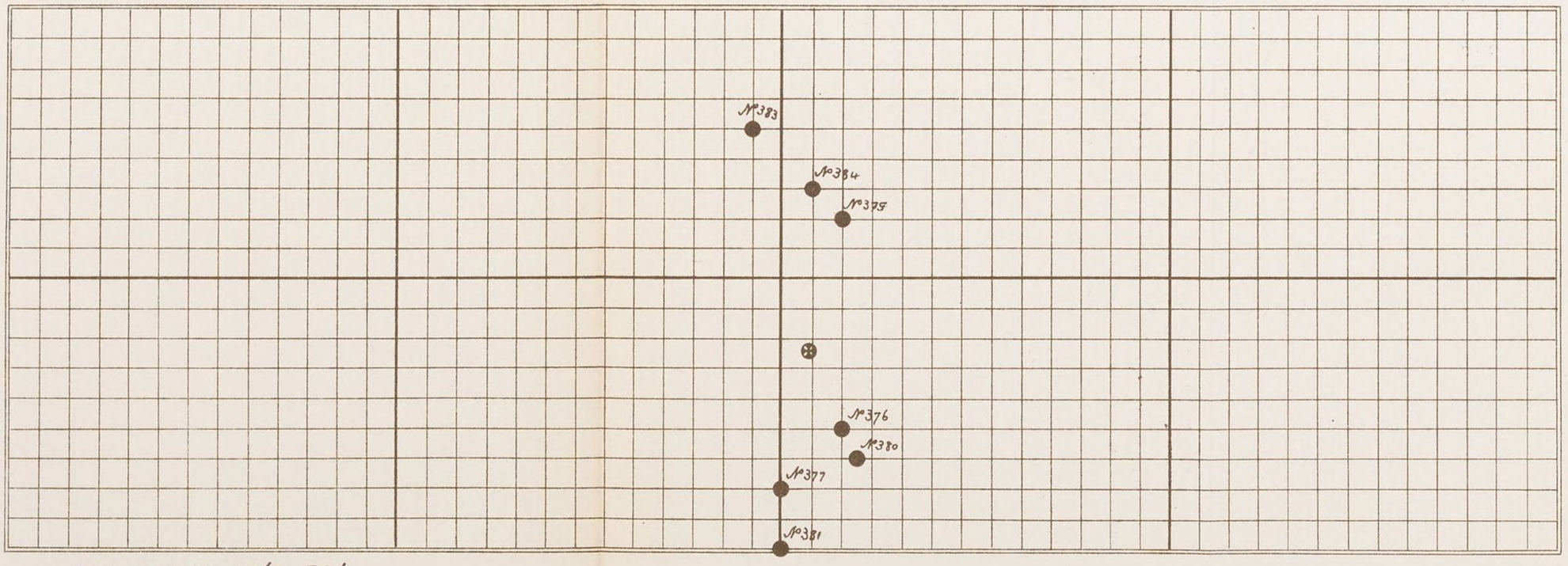
Amund M. Lissak
Lieut. Ord. Dept.

TARGET RECORD OF 3 INCH HOTCHKISS MOUNTAIN GUN

AT SANDY HOOK PROVING GROUND, JUNE 3RD 1892.

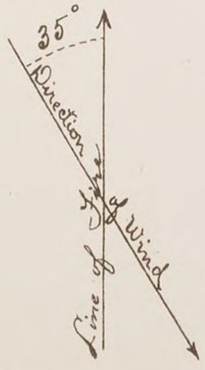
TARGET 1000 YARDS FROM GUN.

NUMBER OF SHOTS FIRED 10 DIRECT HITS 7 RICOCHET HITS 0 MISSES 3



TARGET 18' × 52'

⊛ CENTER OF IMPACT



WIND 10 MILES PER HOUR

MEAN VERTICAL DEVIATION FROM CENTER OF IMPACT ..... 4.94 FT.

MEAN HORIZONTAL DEVIATION FROM CENTER OF IMPACT ..... 1.08 FT.

MEAN DEVIATION FROM CENTER OF IMPACT ..... 5.056 FT.

DEVIATION OF CENTER OF IMPACT FROM LINE OF FIRE .....

GUN SIGHTED BY Lieut. C. B. Wheeler, Ord. Dept.

TARGET OBSERVED BY Sgt. Freeman, Ord. Det.

Charles D. Wheeler

LIEUT. ORDNANCE DEPT U.S.A.

TARGET RECORD OF

NUMBER OF SHOTS FIRED 10

DIRE

TARGET 18" x 32"

⊗ CENTER OF IMPACT

SUN SIGHTED BY

TARGET OBSERVED BY

WIND 10 MILES PER HOUR

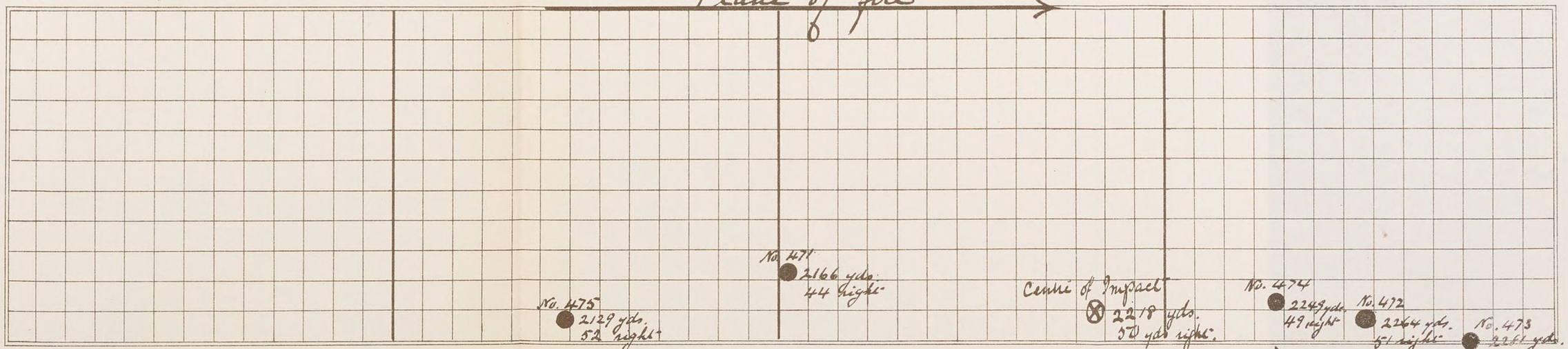
TARGET RECORD OF Hotchkiss 3" Mountain Gun

AT SANDY HOOK, N. J.

Charge 11 oz. I.K.H.
Elevation 11°

Target —— *from Gun.* June 10 1892 a. m.

Number of shots fired: 5 *Number of hits:* 5



Scale, 5 yds. to the square

Wind 6 *miles per hour.* from front

Armord M. Sisak
Lieut. of Ordnance

Appendix 41, 1892.

TARGET RECORD OF Hotchkiss 8" Mountain Gun

AT SANDY HOOK, N. J.

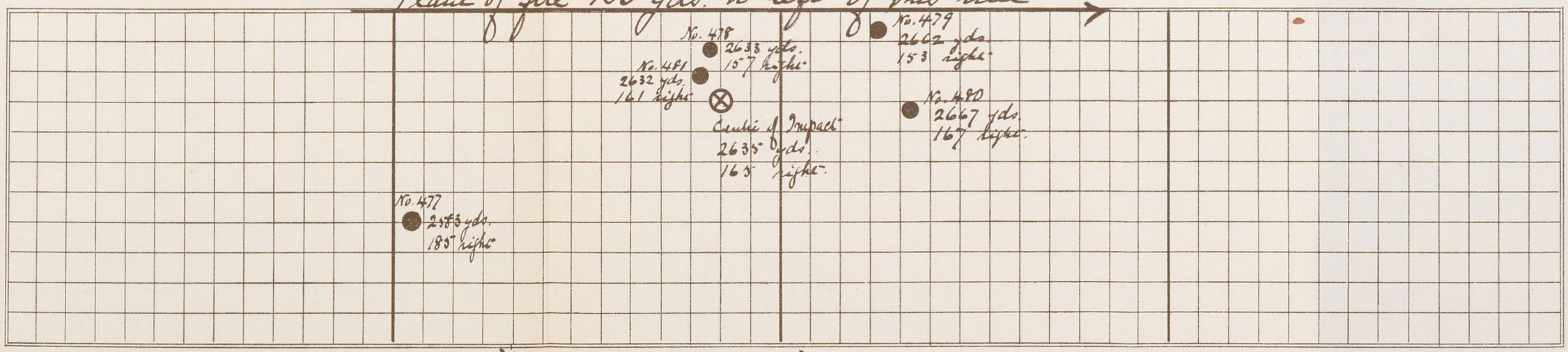
Charge 11 oz. I.K.H.
Elevation 14°

Target — *from Gun.* June 10 1892 P.M.

Number of shots fired: 5

Plane of fire 150 yds. to left of this line

Number of hits: 5



Scale 5" yards to the square

Wind 6 *miles per hour.* from front

Amond Sh. Lissak
Lieut. of Ordnance

TARCET RECORD OF Hotchkiss 3" Mountain Gun

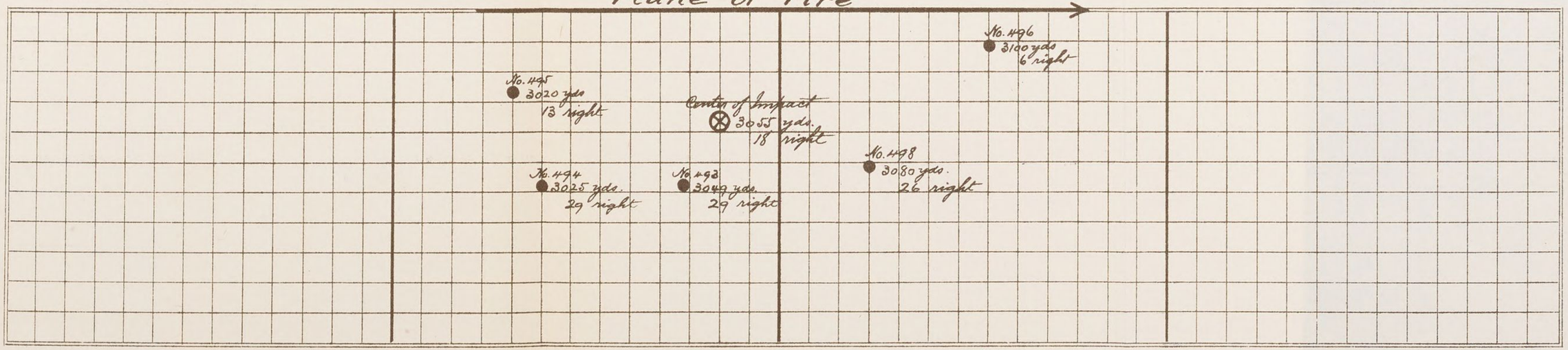
AT SANDY HOOK, N. J. June 11th 1892 a.m.

Charge 1 lb oz. I.K.H.
Elevation 17°

Target ——— *from Gun.*

Number of shots fired: .....

Number of hits: .....



Scale: 5 yards to the square.

Wind 8 *miles per hour.* from front and right 20°

Appendix 41, 1892.

TARGET RECORD OF Hotchkiss 3" Mountain Gun

AT SANDY HOOK, N. J. June 11th 1892 a.m.

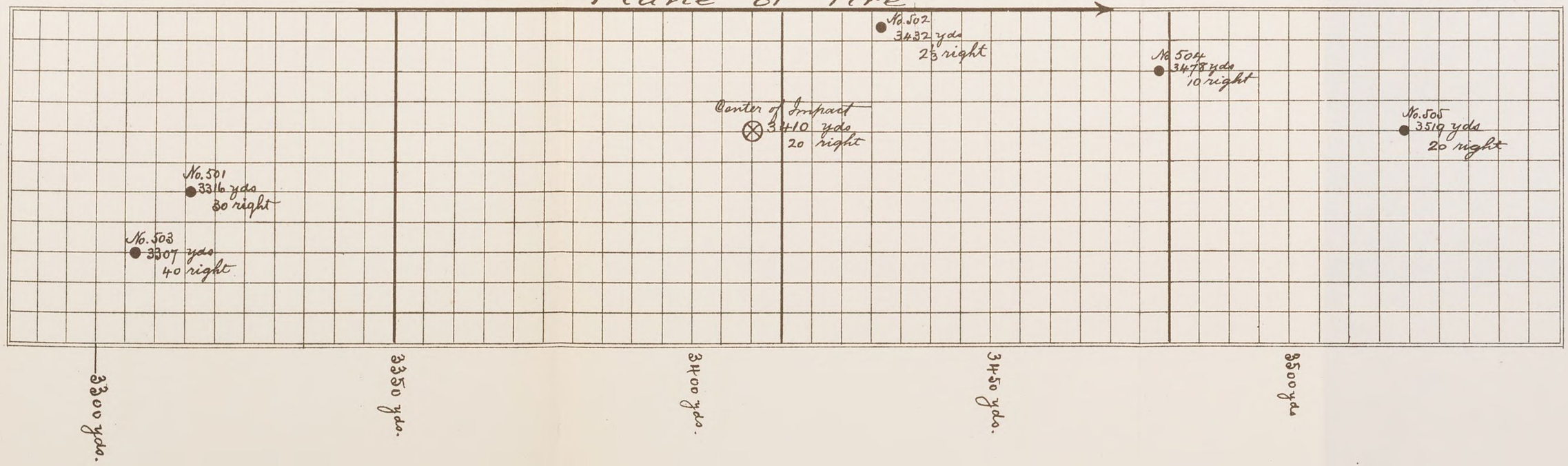
Charge 11oz. I.K.H.
Elevation 20°

Target ——— *from Gun.*

Number of shots fired: 5

Plane of fire →

Number of hits: 5



Scale 5 yards to the square.

Wind 8 *miles per hour.* from Front and Right 20°.

Appendix 41, 1892.

TARGET RECORD OF

SANDY HOOK, N. J.

Range No. 1 N.R.A.

Elevation 20°

Number of shots fired. 5

No. 501
331b gun
Gr triple

No. 502
350 gun
40 triple

No. 503
350 gun
40 triple

Shot strayed to the opposite

APPENDIX 42.

TEST OF THE WOODBRIDGE 10-INCH B. L. RIFLE, CAST IRON, WIRE WOUND (28 TONS), MANUFACTURED AT WATERTOWN AND WATERVLIET ARSENALS, BY THE BOARD FOR TESTING RIFLED CANNON, ETC., APPOINTED UNDER THE ACT OF CONGRESS APPROVED JULY 5, 1884.

(3 plates.)

The 10-inch B. L. rifle, cast iron, wire wound, was turned over to this board at the United States proving ground, Sandy Hook, N. J., for trial, in accordance with instructions from the Chief of Ordnance, U. S. Army, dated Washington, D. C., February 15, 1892.

DESCRIPTION.

The description is omitted here, as it is found fully described by Capt. D. A. Lyle, Ordnance Department, in his construction report of the cast-iron body, Report of the Chief of Ordnance, 1885, page 159; and by Capt. William Crozier, Ordnance Department, in his progress and construction report, Report of the Chief of Ordnance, 1886, page 359.

CARRIAGE.

The gun throughout the test was mounted on a barbette carriage, front pintle, for 15-inch smoothbores, altered to receive it.

The carriage worked well, with the exception that it would not return entirely into battery by the action of gravity, and that the recoil cylinder leaked very badly throughout the test through the rear stuffing box and through a crack in upper strap near the front of the cylinder, both of which it seemed impossible to control, and oil had to be added from time to time throughout the firing.

Before round 11 the rear stuffing box was packed with metal packing and a new gasket was put in front cylinder head, and in round 58 the crack mentioned above had increased in length about 1½ inches. After the ninety-fourth round a part of the metallic packing was removed and replaced by asbestos packing, and after the one hundred and thirty-fourth round all the metallic packing was removed and replaced by asbestos packing.

The bolts in the rear stuffing box were set up from time to time, but did not stop the leakage.

TEST.

The board adopted the following programme for the test of this gun:

TEST FOR ENDURANCE.

The gun to be fired for endurance, as far as the powder at the disposal of the board will permit, with projectiles of about 450 pounds, the pressures to be kept at about 30,000 pounds, and the initial velocities to be not less than 1,800 feet per second.

Velocities and pressures to be taken and the gun to be star gauged as often as the board may deem necessary.

RAPIDITY.

One group of 10 shots to be fired for rapidity, all facilities being used to overcome unnecessary delays in firing.

ACCURACY.

Three groups of eight shots each to be fired for accuracy at a range of 3,000 yards.

RANGE.

Five rounds to be fired for range at the greatest elevation obtainable with the carriage on which the piece is mounted.

FIRINGS.

The gun has been fired, in all, 161 rounds.

POWDER.

The requirements of the powder for this gun are as follows: Charge, 160 pounds; density of loading, 0.9343; weight of shot, 450 pounds; velocity, about 1,800 feet per second.

Pressure about 30,000 pounds per square inch.

The following powders were used, and the number of rounds of each is stated:

	Rounds.
German brown prismatic	12
German brown prismatic received from Watervliet Arsenal May 19, 1891	8
Du Pont's brown prismatic—	
N. V., lot 7	8
N. V., lot 12	3
N. V., lot 8	1
V. C., lot 1	2
V. C., lot 2	31
V. C., lot 3	31
V. C., lot 4	24
V. C., lot 5	39
A blend from V. C., lots 2, 3, and 5	1
A blend from V. C., lots 3 and 4	1
Total	161

Forty-seven of these rounds were fired before the gun was turned over to this board, 19 rounds being for the test of powder and the remainder of the 47 for endurance.

In 125 rounds both the pressure and velocity required were obtained. In 7 rounds the required pressure was obtained, but not the velocity, and 1 round gave the required velocity, but not the pressure.

In 28 rounds neither the required velocity nor pressure were obtained.

The following table shows the characteristics of the different powders:

Kind.	Density.	No. of rounds.	Charge.	Projectiles.	Velocity.	Pressure.
			Pounds.	*Pounds.*	*Feet.*	*Pounds.*
German brown prismatic, stored at proving ground	.....	1	100	450	1,316	12,528
		1	120	450	1,512	18.360
		1	130	.....	1,580	19,440
		1	140	450	1,633	23,800
		2	150	.....	1,692	26,940
		2	154 4/16	450	1,728	27,531
		2	170	450	1,842	31,575
Du Pont's brown prismatic N. V., lot 7	1,830	2	100	450	1,447	18,740
		1	110	.....	1,523	21,850
		1	120	450	1,604	26,060
		1	125	.....	1,682	*28,000
		3	130	450	1,703	32,300
		1	140	450	1,756	30,790
Du Pont's brown prismatic V. C	1,820	1	150	450	1,812	35,435
German brown prismatic received from Watervliet Arsenal May 19, 1891	.....	1	100	450	1,450	28,000
		4	110	451	1,554	29,702
		1	115	452	1,619	34,416
		1	120	451	1,644	33,710
		1	150	451	1,855	†42,000
Du Pont's V. C., lot 2	1,825	1	140	450	1,722	26,135
		1	150	450	1,741	25,620
		2	160	450	1,840	27,920
Du Pont's N. V., lot 12	1,835	1	110	450	1,497	18,033
		1	120	450	1,620	18,050
		1	130	450	1,733	28,672
Du Pont's V. C., lot 3	1,840	2	160	455	1,821	30,915
lot 4	1,840	1	140	452	1,703	24,197
		2	160	453	1,830	30,911
lot 5	1,835	1	140	454	1,691	27,550
		1	150	453	1,762	28,660
		1	160	454	1,835	31,393

*Less than. † Above.

PROJECTILES.

The projectiles were experimental cast iron cored shot, with a single band, weighing 450 pounds. Sometimes the weight was slightly more than this and sometimes sand had to be added to bring them to the required weight.

RAPIDITY.

The ten rounds from the ninety-seventh to the one hundred and sixth, inclusive, were fired for rapidity.

The total time of firing the ten rounds was 1 hour and 10 minutes, but from this must be deducted 6 minutes replacing wooden block holding-elevating screw, and 9 minutes to allow ships to pass, making the actual firing time 55 minutes.

ACCURACY.

Three groups of 8 shots each were fired at the 3,000-yards target for accuracy.

The following tables give the results of these firings:

Charge.	Weight of projectile.	Elevation.	Center of impact.				Mean deviation from center of impact.		Mean deviation from center of impact.	Deviation of center of impact from plane of fire (right).	Wind.	
			Vertical.		Horizontal.							
			Above.	Below.	Right.	Left.	Vertical.	Horizontal.			Direction.	Force.
	Lbs.	°	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*	*Feet.*		*Miles.*
V. C., lot 3, 157 pounds.	449	3	6.25	.....	.....	7.625	3.28	4.53	5.59	9.67	Rear and right, 40°	11
Do.....	447	3	.....	4.25	.....	2.625	5.56	7.968	9.715	10⅓	Rear and right, 40°	11
Do.....	450	3	.....	4.625	12.625	.....	2.968	2.218	3.705	21.00	Front and right, 15°	12

Each of the above tests consists of 8 rounds.

RANGE.

Eight shots were fired at sea for range at the greatest angle of elevation of which the carriage was capable—10 degrees 55 minutes.

The shots were observed from two plane tables at the ends of a base line 9,000 yards long.

The following table gives the results of the firing:

[Eight rounds.]

Charge.	Weight of projectile.	Elevation.	Mean range.	Wind.	
				Direction.	Force.
	Pounds.	° ′	*Yards.*		*Miles.*
V. C., lot 4, 157 pounds	451½	10 55	8,174	Rear.....	10

ENDURANCE.

In the firing record of the gun we find the following remarks:

Round 2. Console came unlatched.

Round 3. Console came unlatched and gas-check pad badly burnt. Gas escaped past pad. Nut on mushroom head tightened after this round.

Round 5. Console came unlatched; new gas-check pad used; escape of gas past pad. Canvas covering of gas-check pad cut away ½ inch in one place.

Round 6. Console came unlatched. Gas escaped past pad. Canvas covering of gas-check pad cut away in two places.

Round 7. Escape of gas. Canvas covering of gas-check pad cut slightly.

Round 9. Console came unlatched. Mushroom head was tightened after this round.

Rounds 11, 12, and 13. Console came unlatched during firing.

Round 14. Console came unlatched. Canvas covering of gas-check pad cut in one place.

Rounds 15 to 20. Console became unlatched during each fire.

Round 23. In opening, in rotating breechblock, first turn made with difficulty.

Round 24. In closing, in rotating breechblock, last turn made with difficulty, mallet being used. Console became unlatched during firing.

Round 25. In closing, in rotating breechblock, last turn was made with difficulty, mallet being used; a small piece of canvas covering of pad torn off.

Round 26. Before this round the rear threads of the breechblock were filed down and rear gas-check cup was smoothed. Console became unlatched.

Round 27. Console became unlatched.

Round 28. Console became unlatched.

Round 30. Console became unlatched.

Rounds 31–34. Console flew open and closed again during discharge.

Round 47. Escape of gas around threads of primer, and stay pin through rotating handle broken, which was repaired before the next round.

Rounds 48–62. Console flew open and closed again during each discharge.

Rounds 63–74. Difficulty in opening breechblock due to arc for rotating gear being burred, the last three teeth being very badly so.

Round 63. Brass vent shield very badly bent and had to be cut off near stud before block could be opened.

Round 75. Before this round arc for rotating gear smoothed down and burrs removed. Mushroom head tightened and rear gas-check cup filed and smoothed.

Round 83. Escape of gas around threads of obturating primer, and this is also noted in rounds 88 to 134, inclusive.

Round 95. Before this round a new vent shield made of steel was fitted to breechblock and seat for Zalinski sight was secured to left trunnion.

Round 135. Before this round impressions taken of bore and shot chamber; erosions of considerable depth in slope of shot chamber; erosions of less depth at forward end of powder chamber and at beginning of rifling.

After the tenth round the chamber was always sponged to facilitate the loading of the projectile.

In round 89 it is noted that the copper washer and first three threads of the pressure gauge was cut by gas, and this escape of gas around threads of pressure gauge is also noted in round 95.

STAR GAUGING.

The gun was star gauged after the second, twelfth, ninety-fourth, and one hundred and sixty-first rounds, and the records are hereto appended.

IMPRESSIONS.

Impressions were made of bore and shot chamber after the one hundred and thirty-fourth and one hundred and sixty-first rounds, and accompany this report.

CONCLUSION.

As this gun consists essentially of a cast-iron body strengthened by steel-wire winding, as it is a gun of inferior power to the standard guns of the day of the same caliber, as its breech mechanism is of an abandoned pattern, and as the limited tests to which it has been sub-

jected have developed deep scoring and guttering, which has been found to be common to cast-iron bores, the board, while it does not consider that the gun has yet developed weaknesses which would condemn it for service, can not upon the whole, from the experience so far, recommend it as in all respects suitable to be put to use in the Government service.

F. H. PARKER,
Lieut. Col., Ord. Dept., U. S. Army, President.
CLIFTON COMLY,
Major, Ordnance Dept., U. S. Army.
J. W. REILLY,
Major, Ordnance Dept., U. S. Army.
FRANK HEATH,
Captain, Ordnance Dept., U. S. Army.
CHARLES B. WHEELER,
(5130–'92.) *Lieut., Ord. Dept., U. S. Army, Recorder.*

Star gauging of 10-inch B. L. rifle, cast-iron, wire-wound, at Sandy Hook proving ground.

JANUARY 30 AND MARCH 19, 1891.

[10-inch ring.]

From muzzle.	After 2 rounds, Jan. 30, 1891 (across lands).	After 12 rounds, Mar. 19, 1891 (across lands).	Increase.	From muzzle.	After 2 rounds, Jan. 30, 1891 (across lands).	After 12 rounds, Mar. 19, 1891 (across lands).	Increase.
Inches.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inches.*	*Inch.*
0	.....	.....	.....	115	10.008	10.010	.002
5	.....	.....	.....	120	10.0065	10.009	.0025
10	10.007	10.009	.002	125	10.007	10.009	.002
15	10.0065	10.010	.0035	130	10.007	10.009	.002
20	10.007	10.010	.003	135	10.0055	10.008	.0025
25	10.007	10.010	.003	140	10.0055	10.008	.0025
30	10.008	10.010	.002	145	10.005	10.009	.004
35	10.0085	10.011	.0025	150	10.005	10.008	.003
40	10.008	10.011	.003	155	10.0045	10.008	.0035
45	10.009	10.011	.002	160	10.0035	10.008	.0045
50	10.009	10.0115	.0025	165	10.0035	10.007	.0035
55	10.009	10.012	.003	170	10.003	10.007	.004
60	10.009	10.011	.002	175	10.003	10.007	.004
65	10.009	10.011	.002	180	10.003	10.007	.004
70	10.007	10.010	.003	185	10.0025	10.007	.0045
75	10.008	10.011	.003	190	10.003	10.007	.004
80	10.008	10.012	.004	195	10.003	10.008	.005
85	10.008	10.011	.003	200	10.002	10.008	.006
90	10.007	10.010	.003	205	10.002	10.008	.006
95	10.008	10.011	.003	210	10.002	10.009	.007
100	10.0085	10.010	.0015	215	10.003	10.009	.006
105	10.007	10.010	.003	220	.....	.....	.....
110	10.008	10.010	.002				

Gun star gauged by Lieut. W. W. Gibson, Ordnance Department.

[10.85-inch ring.]

From breech.	After 2 rounds, Jan. 30, 1890 (vertical).	After 12 rounds, Mar, 19, 1891 (vertical).	Increase.	From breech.	After 2 rounds, Jan. 30, 1891 (vertical).	After 12 rounds, Mar. 19, 1891 (vertical).	Increase.
Inches.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inches.*	*Inch.*
25	10.85	10.852	.002	47	10.85	10.851	.001
27	10.85	10.853	.003	49	10.85	10.852	.002
29	10.85	10.852	.002	51	10.85	10.851	.001
31	10.85	10.853	.003	53	10.85	10.851	.001
33	10.85	10.852	.002	55	10.85	10.852	.002
35	10.85	10.853	.003	57	10.85	10.852	.002
37	10.85	10.853	.003	59	10.85	10.852	.002
39	10.85	10.853	.003	61	10.85	10.852	.002
41	10.85	10.852	.002	63	10.85	10.852	.002
43	10.85	10.8515	.0015	65	10.8505	10.852	.0015
45	10.85	10.852	.002	67	10.851	10.8525	.0015

Gun star-gauged by Lieut. W. W. Gibson, Ordnance Department.

MARCH 7, 1892.

[10-inch ring.]

From muzzle.	After 47 rounds (lands).	Increase.	From muzzle.	After 47 rounds (lands).	Increase.	From muzzle.	After 47 rounds (lands).	Increase.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
0	10.014	.....	75	10.010	.002	150	10.007	.002
5	10.009	.009	80	10.010	.002	155	10.006	.0015
10	10.010	.003	85	10.010	.002	160	10.006	.0025
15	10.010	.0035	90	10.010	.003	165	10.005	.0015
20	10.010	.003	95	10.010	.002	170	10.005	.002
25	10.010	.003	100	10.010	.0015	175	10.005	.002
30	10.010	.002	105	10.010	.003	180	10.005	.002
35	10.010	.015	110	10.010	.002	185	10.005	.0025
40	10.010	.002	115	10.009	.001	190	10.007	.004
45	10.011	.002	120	10.008	.0015	195	10.005	.002
50	10.011	.002	125	10.008	.001	200	10.006	.004
55	10.011	.002	130	10.008	.001	205	10.011	.009
60	10.010	.001	135	10.007	.0015	210	10.012	.010
65	10.010	.001	140	10.007	.0015	215	10.014	.011
70	10.010	.003	145	10.007	.002			

Temperature 70° in sun and 48° in the bore.

[10.85-inch ring.]

From breech.	After 47 rounds (chamber vertical).	Increase.	From breech.	After 47 rounds (chamber vertical).	Increase.	From breech.	After 47 rounds (chamber vertical).	Increase.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
67	10.855	.004	51	10.852	.002	35	10.852	.002
65	10.855	.0045	49	10.852	.002	33	10.852	.002
63	10.855	.005	47	10.851	.001	31	10.852	.002
61	10.854	.004	45	10.852	.002	29	10.853	.003
59	10.854	.004	43	10.852	.002	27	10.853	.003
57	10.852	.002	41	10.852	.002	25	10.853	.003
55	10.852	.002	39	10.852	.002			
53	10.852	.002	37	10.852	.002			

Temperature 70° in sun, and 48° in the bore.

[10.85-inch ring.]

From muzzle.	After 47 rounds (chamber horizontal).	From muzzle.	After 47 rounds (chamber horizontal).	From muzzle.	After 47 rounds (chamber horizontal).	From muzzle.	After 47 rounds (chamber horizontal).
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
67	10.856	55	10.853	43	10.852	31	10.854
65	10.854	53	10.853	41	10.852	29	10.854
63	10.854	51	10.852	39	10.853	27	10.854
61	10.854	49	10.852	37	10.853	25	10.854
59	10.854	47	10.852	35	10.853		
57	10.853	45	10.851	33	10.853		

No horizontal measurements of chamber previously taken.

APRIL 4, 1892.

[10-inch ring.]

From muzzle.	After 94 rounds (lands).	Increase.	From muzzle.	After 94 rounds (lands).	Increase.	From muzzle.	After 94 rounds (lands).	Increase.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
0	10.017		75	10.010	.002	150	10.007	.002
5	10.010	.010	80	10.010	.002	155	10.006	.0015
10	10.010	.003	85	10.010	.002	160	10.006	.0025
15	10.010	.0035	90	10.010	.003	165	10.007	.0035
20	10.010	.003	95	10.009	.001	170	10.008	.005
25	10.010	.003	100	10.010	.0015	175	10.008	.005
30	10.010	.002	105	10.010	.003	180	10.009	.006
35	10.010	.0015	110	10.010	.002	185	10.010	.0075
40	10.010	.002	115	10.009	.001	190	10.015	.012
45	10.010	.001	120	10.008	.0015	195	10.021	.018
50	10.010	.001	125	10.007	.000	200	10.027	.025
55	10.010	.001	130	10.008	.001	205	10.035	.033
60	10.009	.000	135	10.007	.0015	210	10.043	.041
65	10.010	.001	140	10.007	.0015	215	10.048	.045
70	10.009	.002	145	10.007	.002	220	10.060	

Thermometer 99° in sun, 75° in bore. Piece in sun in front of trunnions.

[10.85-inch ring.]

From breech.	After 94 rounds (chamber vertical).	Increase.	From breech.	After 94 rounds (chamber vertical).	Increase.	From breech.	After 94 rounds (chamber vertical).	Increase.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
67	10.872	.021	51	10.855	.005	35	10.852	.002
65	10.867	.0165	49	10.854	.005	33	10.852	.002
63	10.864	.014	47	10.853	.003	31	10.852	.002
61	10.863	.013	45	10.852	.002	29	10.852	.002
59	10.862	.012	43	10.852	.002	27	10.853	.003
57	10.860	.010	41	10.852	.002	25	10.853	.003
55	10.858	.008	39	10.852	.002	23	10.853	.003
53	10.856	.006	37	10.852	.002	21	10.853	.003

Piece in shade, in rear of trunnions. Thermometer 81° in shade.

[10.85-inch ring.]

From breech.	After 94 rounds.	Increase.	From breech.	After 94 rounds.	Increase.	From breech.	After 94 rounds.	Increase.
Inches.	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*
67	10.869	.018	51	10.855	.005	35	10.852	.002
65	10.867	.0165	49	10.854	.004	33	10.853	.003
63	10.866	.016	47	10.853	.003	31	10.853	.003
61	10.864	.014	45	10.852	.002	29	10.853	.003
59	10.861	.011	43	10.852	.002	27	10.853	.003
57	10.859	.009	41	10.852	.002	25	10.853	.003
55	10.858	.008	39	10.852	.002	23	10.853	.003
53	10.858	.008	37	10.852	.002	21	10.853	.003

Piece in shade, in rear of trunnions. Thermometer 81° in shade.

SEPTEMBER 12, 1892, AND JANUARY 30, 1891.

From muzzle.	After 161 rounds, Sept. 12, 1892.	After second round, Jan. 30, 1891.	Increase.	From muzzle.	After 161 rounds, Sept. 12, 1892.	After second round, Jan. 30, 1891.	Increase.
Inches.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inches.*	*Inch.*
0	10.02	.....	.....	115	10.012	10.008	.004
5	10.02	.....	.....	120	10.011	10.0065	.0045
10	10.011	10.007	.004	125	10.0115	10.007	.0045
15	10.011	10.0065	.0045	130	10.012	10.007	.005
20	10.011	10.007	.004	135	10.011	10.0055	.0055
25	10.011	10.007	.004	140	10.012	10.0055	.0065
30	10.011	10.008	.003	145	10.011	10.005	.006
35	10.011	10.0085	.0025	150	10.0115	10.005	.0065
40	10.012	10.008	.004	155	10.011	10.0045	.0065
45	10.0125	10.009	.0035	160	10.013	10.0035	.0095
50	10.0125	10.009	.0035	165	10.013	10.0035	.0095
55	10.013	10.009	.004	170	10.016	10.003	.013
60	10.012	10.009	.003	175	10.017	10.003	.014
65	10.0125	10.009	.0035	180	10.022	10.003	.019
70	10.012	10.007	.005	185	10.025	10.0025	.0225
75	10.013	10.008	.005	190	10.032	10.003	.029
80	10.0135	10.008	.0055	195	10.039	10.003	.031
85	10.013	10.008	.005	200	10.047	10.002	.045
90	10.012	10.007	.005	205	10.061	10.002	.059
95	10.012	10.008	.004	210	.....	10.002	.....
100	10.012	10.0085	.0035	215	.....	10.003	.....
105	10.0111	10.007	.0045	220	.....	.....	.....
110	10.012	10.008	.004				

Temperature, 76°; gun and ring same temperature.

[10.85-inch ring.]

From breech.	After 161 rounds, Sept. 12, 1892 (vertical).	After 2 rounds, Jan. 30, 1891 (vertical).	Increase.	From breech.	After 161 rounds, Sept. 12, 1892 (vertical).	After 2 rounds, Jan. 30, 1891 (vertical).	Increase.
Inches.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inches.*	*Inch.*
20	10.929	.....	.....	43	10.852	10.85	.002
21	10.868	.....	.....	45	10.8525	10.85	.0025
22	10.853	.....	.....	47	10.8535	10.85	.0035
23	10.853	.....	.....	49	10.855	10.85	.005
24	10.853	.....	.....	51	10.856	10.85	.006
25	10.853	10.85	.003	53	10.861	10.85	.011
27	10.853	10.85	.003	55	10.863	10.85	.013
29	10.853	10.85	.003	57	10.8665	10.85	.0165
31	10.853	10.85	.003	59	10.871	10.85	.021
33	10.853	10.85	.003	61	10.874	10.85	.024
35	10.8525	10.85	.0025	63	10.877	10.85	.027
37	10.852	10.85	.002	65	10.883	10.8505	.0325
39	10.852	10.85	.002	67	10.887	10.851	.036
41	10.852	10.85	.002				

Temperature, 79°; gun and ring same temperature. Day cloudy.

[10.85-inch ring.]

From breech.	After 161 rounds, Sept. 12, 1892 (horizontal).	From breech.	After 161 rounds, Sept. 12, 1892 (horizontal).	From breech.	After 161 rounds, Sept. 12, 1892 (horizontal).	From breech.	After 161 rounds, Sept. 12, 1892 (horizontal).
Inches.	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*	*Inches.*
20	10.926	29	10.853	43	10.8525	57	10.8675
21	10.857	31	10.8525	45	10.8525	59	10.871
22	10.853	33	10.8525	47	10.855	61	10.8765
23	10.853	35	10.852	49	10.856	63	10.880
24	10.853	37	10.852	51	10.8575	65	10.8825
25	10.8525	39	10.852	53	10.859	67	10.886
27	10.853	41	10.852	55	10.863		

Temperature, 79°; gun and ring same temperature. Day cloudy.

Star gauging after one hundred and sixty-first round not reliable after 180 inches from muzzle, as rifling was worn so that guide would not always keep points on lands.

Record of firing with 10-inch B. L. rifle (cast iron), wire wound (28 tons),

[Object of firing, to

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.	Instrumental velocity, 165 feet from muzzle.
			Kind.	Weight.	Kind.	Weight.			
P. M.				*Lbs. Oz.*		*Lbs. Oz.*	*Inches.*	° ′	*Feet.*
Jan. 28	.....	1	German brown prismatic; 43 prisms in cross section.	75 0 744 prisms brown; 7 prisms black.	Cored shot (experimental), lot 188.	450 0 natural weight.	227.25	0 20	.....
A. M. Jan. 30	.....	2		100 0 995 prisms brown; 7 prisms black.		450 0 natural weight.	227.25	0 15	{ 1,317 1,314 90+½
P. M. Feb. 4	3	3		120 0 1,197 prisms brown; 7 prisms black.		450 0 natural weight.	227.25	0 05	{ 1,512 Lost.
Feb. 4	4	4		130 0 1,295 prisms brown; 7 prisms black.		450 0 natural weight.	227.25	0 05	{ 1,583 1,577

Watervliet Arsenal, at Sandy Hook, N. J., January 28 to February 4, 1891.

test gun for endurance.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Ft. In.*		*Ft. In.*		
C, less than 9,000. D, less than 9,000.	4 11	From right, 3 miles an hour.	4 8	Shot came out of butt. Copper cylinders of 9,000 pounds initial compression.	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle. Twenty-four gallons of oil in cylinder. Oil measured 5½ inches at filling hole. Fired into sand butt, section 1. Obturating electric primers (improved); lot of April 29, 1890. Firing conducted by the proof officer.
C, 12, 315..... D, 12, 740.....	5 0	From right, 11 miles an hour.	5 0	One primer fired, but failed to ignite cartridge; cartridge had been pushed too far into chamber; block opened and cartridge drawn back slightly. Shot struck in front of butt and ricocheted over. Console came unlatched. Copper cylinders of 9,000 pounds initial compression and tables of 1887.	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle. One gallon of oil added to cylinder before firing; oil measured 6 inches at filling hole. Cartridge bag cut. Fired into sand butt. Obturating electric primers (improved); lot of April 29, 1890. Firing conducted by the proof officer. Bore of gun star-gauged after second round, January 30, 1891, by Lieut. W. W. Gibson, Ordnance Department. Chamber of gun star-gauged February 2, 1891, by Lieut. W. W. Gibson, Ordnance Department.
C, 18,780..... D, 17,940.....	4 6	From rear and right, 20 miles an hour.	4 3	First primer failed to ignite cartridge. Console became unlatched. Gas-check pad badly burnt; gas escaped past pad. Nut on mushroom head tightened after this round. One gallon of oil drawn from cylinder; depth of oil then measured 5 inches. Copper cylinders of 9,000 pounds initial compression and tables of 1887. Copper cylinders of 18,000 pounds initial compression and tables of 1887.	Gun mounted on barbette carriage; front pintle altered for 10-inch rifle. One gallon of oil added to cylinder before firing; depth of oil measured 5¼ inches. Fired to sea. Cartridge bag cut. Obturating electric primers (improved) April 29, 1890. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by the proof officer.
C, 19,880..... D, 20,000.....	4 8	From rear and right, 20 miles an hour.	4 5	.....	

Record of firing with 10-inch B. L. rifle (cast iron), wire wound (28 tons),

[Object of firing, to

Date.	No. of series.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore.	Elevation.	Instrumental velocity, 165 feet from muzzle.
				Lbs. Oz.		*Lbs. Oz.*	*Inches.*	° ′	*Feet.*
A. M. Feb. 24	5	5	German brown prismatic; 43 prisms in cross section.	140 0 1.398 prisms brown; 7 prisms black.	Cored shot (experimental), lot 188.	450 0 natural weight.	227.25	0 10	{ 1,640 1,625 90+½°
Mar. 4	6	6	German brown prismatic; 43 prisms in cross section.	150 0 1,497 prisms brown; 7 prisms black.	Cored shot (experimental), lot 188.	450 0 natural weight.	227.25	0 05	{ 1,690 1,683 90+½°
Mar. 11	7	7	German brown prismatic; 43 prisms in cross section.	150 0 1,498 prisms brown; 7 prisms black.	Cored shot (experimental), lot 188.	450 0 natural weight.	227.15	0 10	{ Lost. 1,697
P. M. Mar. 11	8	8	Du Pont's sphero-hexagonal O. X. C.; density, 1.795; granulation, 100.	154 4 1,541 prisms brown; 7 prisms black.	Cored shot (experimental), lot 188.	450 0 natural weight.	227.25	0 10	{ Lost. 1,718

Watervliet Arsenal, at Sandy Hook, N. J., February 24 to March 11, 1891.

test gun for endurance.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Ft. In.*		*Ft. In.*		
C, 23.800.....	.....	From front and left, 7 miles an hour.	.....	Carriage 3 inches out of battery when gun was fired. Console became unlatched during firing. Carriage recoiled to buffers. Escape of gas past pad. Canvas covering of gas-check pad cut away ½ inch in one place. Counter recoil complete.	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle. One-half gallon of oil added to cylinder before firing; depth of oil in cylinder measured 5¼ inches. Cartridge bag cut. Fired into sand butt, section 2. New gas-check pad used. Copper cylinders of 18,000 pounds initial compression and tables of 1887. Pressure taken by Lieut. C. B. Wheeler, Ordnance Department. Velocity taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
C, 26,580..... D, 26,780.....	5 8	From right and rear, 18 miles an hour.	5 08	.....	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle. Three gallons of oil added to cylinder before firing. Depth of oil in cylinder measured 5¾ inches. Cartridge bag cut. Fired to sea. Obturating electric primers; lot of April 29, 1890. Copper cylinders of 24,000 pounds initial compression and tables of 1887. Velocities taken by Lieut. W. W. Gibson, Ordnance Department. Pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
C, 27, 200..... D, 27, 200.....	4 10	From right, 12 miles an hour.	4 10	First primer exploded, but failed to ignite cartridge. Canvas covering of gas-check pad cut slightly; escape of gas.	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle. Obturating electric primers; lot of April 29, 1890. Cartridge bag cut. Fired to sea. Copper cylinders of 24,000 pounds initial compression and tables of 1887.
C, 27,240..... D, 27,200.....	4 11	From front,	4 11	No escape of gas. Warming charge fired before round 8.	Pressures and velocities taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.

Record of firing with 10-inch B. L. rifle (cast iron), wire wound (28 tons),

[Object of firing, to

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.	Instrumental velocity, 165 feet from muzzle.
			Kind.	Weight.	Kind.	Weight.			
A. M.				*Lbs. Oz.*		*Lbs. Oz.*	*Inches.*	° ′	*Feet.*
Mar. 16	9	9	German brown prismatic; 43 prisms in cross section.	154 4 1,541 prisms brown; 7 prisms black.	Cored shot (experimental), lot 188.	450 0 natural weight.	227.25	0 05	{ Lost. { 1,738 90+½
P. M.									*200 feet from muzzle.*
Mar. 16	10	10		158 8 1,584 prisms brown; 7 prisms black.		450 0 natural weight.	227.15	0 05	Lost ....
Mar. 18	11	11		170 0 1,699 prisms brown; 7 prisms black.		450 0 natural weight.	227.25	0 10	{ Lost. { 1,843
Mar. 18	12	12		170 0 1,699 prisms brown; 7 prisms black.		450 0 natural weight.	227.25	0 10	{ 1,842 { 1,839 90+½
A. M.									
Apr. 7	13	13	Du Pont's brown prismatic N. V., lot 7; density, 1.830; 43 prisms in cross section.	100 0 1,071 prisms brown; 5 prisms black.		450 0 natural weight.	227.25	0 10	{ 1,456 { 1,452 90+½

Watervliet Arsenal, at Sandy Hook, N. J., from March 16 to April 7, 1891.

test gun for endurance.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Ft. In.*		*Ft. In.*		
C, 27,240 ..... D, 27,945	5 9	From right and rear, 20 miles an hour.	5 6	Carriage 2 inches out of battery when gun was fired. Console became unlatched during firing. First velocity frame blown over by blast. Mushroom head was tightened after this round.	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle. A warming charge of 50 pounds of Du Pont's sphero-hexagonal was fired before round 9. Obturating electric primers (improved), April 29, 1890. Cartridge bag cut. Fired to sea. Chamber sponged out to facilitate loading of projectile. Copper cylinders of 24,000 pounds initial compression and tables of 1887. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer.
C, 26,940 ..... D, 27,660	5 9		5 9	Carriage 2 inches out of battery when gun was fired. Chronometer of chronograph jarred down.	
D, 32,460 ..... C, 32,980	5 2		4 10	Carriage 2 inches out of battery when gun was fired. Console became unlatched during firing. First primer exploded, but failed to ignite cartridge. Copper cylinders of 24,000 pounds initial compression and tables of 1887.	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle. Since last firing the cylinder has been repacked and a new gasket put in. Depth of oil in cylinder measured 5¾ inches. Cartridge bag cut. Fired to sea.
C, 31,135 ..... D, 29,725	5 2	From front, 12 miles an hour.	4 9	Carriage 2 inches out of battery when gun was fired. Console became unlatched during firing. Gauge C, copper cylinder of 28,000 pounds initial compression and tables of 1887. Gauge D, copper cylinder of 24,000 pounds initial compression and tables of 1887.	Obturating electric primers April 29, 1890. Chamber sponged out to facilitate loading of projectile. Cylinder leaked slightly during the firing. Pressures and velocities taken by Lieut. W. W. Gibson, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer. Gun star-gauged after round 12. March 19, 1891, by Lieut. W. W. Gibson, Ordnance Department.
C less than 24,000. D less than 24,000.	5 0	.....	4 8	Carriage 1½ inches out of battery when gun was fired; first primer failed. Console became unlatched. Copper cylinders of 24,000 pounds initial compression and tables of 1887.	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle. Obturating friction primers. Fired to sea. Cartridge bag cut. Cylinder leaked slightly during the firing at rear end. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.

Record of firing with 10-inch B. L. rifle (cast iron), wire wound (28 tons)

[Object of firing, to

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.		Instrumental velocity, 165 feet from muzzle.
			Kind.	Weight.	Kind.	Weight.				
A. M.				*Lbs. Oz.*		*Lbs. Oz.*	*Inches.*	°	′	*Feet.*
Apr. 8	14	14	7; density, 1.830; 43 prisms in cross section.	100 0 1,071 prisms brown; 5 prisms black.	Cored shot (experimental), lot 188.	450 8 natural weight.	227.25	0	10	1,440 1,439
Apr. 8	15	15		110 0 1,179 prisms brown; 5 prisms black.		450 0 natural weight.	227.25	0	10	1,521 1,526
Apr. 8	16	16		120 0 1,286 prisms brown; 5 prisms black.		450 0 natural weight.	227.25	0	10	1,602 1,605
P. M.										
Apr. 8	17	17		130 0 1,398 prisms brown; 5 prisms black.		447 8 2 8 sand.	227.25	0	10	1,683 1,689 $90+\frac{150}{2}$
Apr. 14	18	18	Du Pont's brown prismatic N. V., lot 7; density, 1.830.	130 0 1,392 prisms brown; 5 prisms black.		449 0 1 0 sand. 450 0	227.25	0	10	Lost. 1,716
Apr. 14	19	19		125 0 1,332 prisms brown; 5 prisms black.		449 0 1 0 sand. 450 0	227.25	0	10	1,682 Lost.
Apr. 14	20	20		130 0 1,392 prisms brown; 5 prisms black.		450 0 natural weight.	227.25	0	10	Lost. 1,707 $90+\frac{150}{2}$

Watervliet Arsenal, at Sandy Hook, N. J., April 8 and 14, 1891.

test gun for endurance.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Ft. In.*		*Ft. In.*		
C 18,940 ..... } D 18,540 ..... }	4 10	.....	4 6	Carriage 2 inches out of battery when gun was fired. Console became unlatched. Canvas covering of gas-check pad cut in one place. Copper cylinders of 9,000 pounds initial compression and tables of 1887.	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle.
C 21,900 ..... } D 21,800 ..... }	4 10	.....	4 10	Carriage 2⅛ inches out of battery when gun was fired. Console became unlatched. Copper cylinders of 18,000 pounds initial compression and tables of 1887.	Obturating electric primer. Depth of oil in cylinder measured after round 15, measuring 5½ inches; 2 quarts of oil added, measuring 5¾ inches.
C 26,155 ..... } D 25,965 ..... }	4 10	.....	4 3	Carriage 2 inches out of battery when gun was fired. Console became unlatched. Copper cylinders of 18,000 pounds initial compression and tables of 1887.	Chamber sponged out after each round, to facilitate loading of projectile. Cartridge bag cut. Fired to sea, Slight leakage of oil at rear end of cylinder during the firing. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
C 32,260 ..... } D 32,050 ..... }	5 0	.....	4 11	Carriage 2 inches out of battery when gun was fired. Console became unlatched. Copper cylinders of 24,000 pounds initial compression and tables of 1887 used in gauge C; copper cylinders of 28,000 pounds initial compression and tables of 1887 used in gauge D.	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle. Obturating electric primers Cartridge bag cut. Copper cylinders of 28,000 pounds initial compression and tables of 1887. Fired to sea. Chamber sponged out after each round to facilitate loading of projectile. Console became unlatched during each fire. Connectors on rim wires loosened by blast, causing loss of velocity record. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
C 33,500 ..... } D 33,600 ..... }	5 0	.....	4 5½	Carriage 2 inches out of battery when gun was fired. First primer failed to ignite charge, due to grease on priming prisms. New prisms placed in cartridge and gun fired.	
{ C less than 28,000. D less than 28,000. }	5 0	.....	4 11	.....	
C 31,240 ..... } D 31,150 ..... }	5 0	.....	4 6	.....	

Record of firing with 10-inch B. L. rifle (cast iron), wire wound (28 tons),

[Object of firing, to obtain

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.	Instrumental velocity, 165 feet from muzzle.
			Kind.	Weight.	Kind.	Weight.			
				Lbs. Oz.		*Lbs. Oz.*	*Inches.*	° ′	*Feet.*
A. M. May 12	1	21	Du Pont's brown prismatic V. C.; density, 1.820.	140 0 1,496 prisms brown; 5 prisms black.	Cored shot (experimental), lot 188.	450 0 natural weight.	227.15	0 25	{ 1,758 1,753
P. M. May 12	2	22		150 0 1,599 prisms brown; 5 prisms black.		451 0 natural weight.	227.15	0 30	{ 1,813 1,810 90+½
May 28	.....	23	Du Pont's brown prismatic V. C.; density, 1.820.	150 0 1,604 prisms brown; 7 prisms black.		451 0 natural weight.	227.00	0 10	{ 1,855 1,855
May 28	.....	24	Powder received from Watervliet Arsenal, May 19, 1891.	120 0 1,283 prisms brown; 7 prisms black.		451 0 natural weight.	227.00	0 10	{ 1,644 1,644 90+½
June 1	.....	25	German brown prismatic, received	115 0 1,228 prisms brown; 7 prisms black.		452 0 natural weight.	227.00	0 10	{ 1,618 1,619 90+½

Watervliet Arsenal, at Sandy Hook, N. J., from May 12 to June 1, 1891.

velocities and pressures.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Ft. In.*		*Ft. In.*		
C 30,760 ..... } D 30,820 ..... }	.....	.....	.....	Carriage 1½ inches out of battery when gun was fired. Cylinder head in rear leaking badly after this firing. Copper cylinders of 28,000 pounds initial compression and tables of 1890.	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle. Depth of oil in cylinder, 5¾ inches.
C 35,720 ..... } D 35,150 ..... }	.....	.....	.....	Carriage 1½ inches out of battery when gun was fired. Leakage in cylinder head continues. Copper cylinders of 28,000 pounds initial compression in gauge C. Copper cylinder of 32,000 pounds initial compression in gauge D, tables of 1890.	Fired into sand butt, section 1. Cartridge bag cut. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
*C, above 42,000 } *D, above 42,000 }	5 0	.....	5 0	Carriage 1⅛ inches out of battery when gun was fired. First velocity target blown out of frame. In opening in rotating breechblock first turn made with difficulty. Copper cylinders of 24,000 pounds initial compression and tables of 1887.	Gun mounted on barbette carriage. Front pintle, altered for 10-inch rifle. One gallon of oil added to cylinder before this firing. Depth of oil in cylinder measured 5¾ inches.
C, 33,900 ..... } D, 33,520 ..... }	4 8	.....	4 8	Carriage 2 inches out of battery when gun was fired. In closing in rotating breechblock last turn made with difficulty, mallet being used. Console became unlatched during firing. Copper cylinders of 32,000 pounds initial compression and tables of 1890.	Fired to sea. Cartridge bag cut. Slight leakage of oil at rear end of cylinder. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
C, 34,477 ..... } D, 34,355 ..... }	4 4	.....	4 0	Carriage three-quarters inch out of battery when gun was fired. In closing in rotating breechblock last turn was made with difficulty, mallet being used. A small piece of canvas covering of gas-check pad torn off. Copper cylinders of 2,800 pounds initial compression and tables of 1890 used in gauge C. Copper cylinders of 32,000 pounds initial compression and tables of 1890 used in gauge D.	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle. Two quarts of oil added to cylinder before this firing. Depth of oil in cylinder measured 5¾ inches. Fired to sea. Cartridge bag cut. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.

* NOTE BY DR. WOODBRIDGE.—An extension of the table of compressions shows that the indication of gauge C was 47,980 and of gauge D was 49,310.

Record of firing with 10-inch B. L. rifle (cast iron), wire wound (28 tons),

[Object of firing, to obtain

Date.	No. of series.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.	Instrumental velocity, 165 feet from muzzle.
			Kind.	Weight.	Kind.	Weight.			
				Lbs. Oz.		*Lbs. Oz.*	*Inches.*	° ′	*Feet.*
P. M. June 3	.....	26	German brown prismatic, received from Watervliet Arsenal, May 19, 1891.	100 0 1,068 prisms brown; 7 prisms black.	Cored shot (experimental), lot 188.	450 0 natural weight.	227.00	0 10	{ 1,452 1,448
A. M. June 4	.....	27		110 0 1,175 prisms brown; 7 prisms black.		450 0 natural weight.	227.00	0 10	{ 1,534 1,536
June 4	.....	28		110 0 1,175 prisms brown; 7 prisms black.		451 0 natural weight.	227.00	0 10	{ 1,556 1,556
June 4	.....	29		110 0 1,175 prisms brown; 7 prisms black.		449 0 2 0 sand. 451 0	227.00	0 10	{ 1,562 1,560
June 4	.....	30		110 0 1,175 prisms brown; 7 prisms black.		451 0 natural weight.	227.00	0 10	{ 1,565 1,564

Watervliet Arsenal, at Sandy Hook, N. J., June 3 and 4, 1891.

velocities and pressures.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Ft. In.*		*Ft. In.*		
C, 28,000..... D, less than 32,000.	5 0	.....	4 10	Carriage 2 inches out of battery when this gun was fired. First primer failed to ignite charge. Console became unlatched during firing. Gauge C, copper cylinders of 28,000 pounds initial compression and tables of 1890. Gauge D, copper cylinders of 32,000 pounds initial compressions and tables of 1890.	Gun mounted on barbette carriage. Front pintle altered for 10-inch rifle. Obturating electric primers. Cartridge bags cut.
C, 29,080..... Less than 32,000.	5 0	.....	4 10	Carriage 2 inches out of battery when gun was fired. Console became unlatched during firing. Gauge C, copper cylinders of 28,000 pounds initial compression and tables of 1890. Gauge D, copper cylinders of 32,000 pounds initial compression and tables of 1890.	Chamber sponged out after each round to facilitate loading of projectile. Fired into sand butt, section 4, rounds 27 to 30, inclusive; round 26 fired to sea. Slight leakage of oil at rear end of cylinder during the firing.
F, 29,750..... H, less than 32,000.	5 0	.....	4 9	Carriage 2 inches out of battery when gun was fired. Console became unlatched during firing. Gauge F, copper cylinders of 28,000 pounds initial compression and tables of 1890. Gauge H, copper cylinders of 32,000 pounds compression and tables of 1890.	Before this firing the rear threads of breechblock filed down and rear gas-check cup smoothed. Copper cylinders of 28,000 pounds initial compression and tables of 1890 used in rounds 29 and 30. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
C, 29,775..... D, 29,500.....	5 0	.....	4 9	Carriage 2 inches out of battery when gun was fired. First velocity frame blown down by blast.	
F, 29,546..... H, 30,564.....	5 0	.....	4 9	Carriage 2 inches out of battery when gun was fired. Console became unlatched. First velocity frame blown down and broken by blast.	

Record of firing with 10-inch B. L. rifle (cast iron), wire wound,

[Object of firing,

Date.	Kind of powder.	No. of prisms.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.
				Kind.	Weight.	Kind.	Weight.		
A. M.					*Lbs. Oz.*		*Lbs.*	*Inches.*	° ′
Dec. 14	Du Pont's brown prismatic V. C., lot 2; density, 1.825; 43 prisms in cross section.	Brown..1,505 Black.....5	31	.....	140 0	Cored shot (experimental), lot 188.	447 3 sand. 450	226.95	0 10
Dec. 15		Brown...812 Brown...805 Black.....5	32	Front cartridge. Rear cartridge.	75 0 75 0 150 0		450 natural weight.	226.95	0 10
Dec. 15		Brown...866 Brown...861 Black.....5	33	Front cartridge. Rear cartridge.	80 0 80 0 160 0		449 1 sand. 450	226.95	0 10
Dec. 15		Brown...864 Brown...865 Black.....5	34	Front cartridge. Rear cartridge.	80 0 80 0 160 0		450 natural weight.	226.95	0 10
P. M.									
Dec. 23	Du Pont's brown prismatic, N. V., lot 12; density, 1.835.	.....	35	.....	110 0 1,190 prisms brown; 7 prisms black.	Cored shot, lot 188.	450 natural weight.	227.50	0 15
Dec. 26		.....	36	.....	100 0 1,079 prisms brown; 7 prisms black.		450 natural weight.	227.50	0 00
Dec. 26		.....	37	.....	120 0 1,220 prisms brown; 7 prisms black.		450 natural weight.	227.50	0 15
Dec. 26		.....	38	.....	130 0 1,406 prisms brown; 7 prisms black.		447 3 sand. 450	227.50	0 15

Watervliet Arsenal, at Sandy Hook, N. J., December 14 to 26, 1891.

to prove powder.]

Instrumental velocity, 165 feet from muzzle.	Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.	*Pounds.*	*Ft. In.*		*Ft. In.*		
1,727 1,717	I, 26,100 M, 26,171	5 0	From rear 180°, 11 miles an hour.	5 0	.....	Gun mounted on barbette carriage. Fifteen gallons of oil put in cylinders, measuring 5¾ inches at filling hole. Obturating electric primers. Fired to sea. Slight leakage of oil at rear end of cylinders during firing.
Lost. 1,741	I, 24,100 M, 27,140	5 4		5 4	One gallon of oil added to cylinders before firing this round. Measuring 6 inches at filling hole. Console flew open and closed again during discharge.	
1,844 1,844	I, 28,877 M, 30,066	5 4	From front 0°, 15 miles an hour.	5 4	.....	Copper cylinders of 24,000 pounds initial compression and tables of 1890. Velocities and pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer. Accepted.
1,833 1,838	I, 28,673 M, 24,066	5 4		5 4	.....	
90+1½°						
1,492 1,501	A, less than 18,000 J, 18,033	2 8½	From front and right 80°, 16 miles an hour.	2 6	Fired into sand butt. Shot struck top of second frame and near top of butt.	Gun mounted on barbette carriage. Obturating electric primers. New recoil indicator secured to top carriage before round 35. Fired to sea.
.....	.....	2 6		2 6	Warming charge.....	Copper cylinders of 1,800 pounds initial compression and tables of 1890 used in rounds 35 and 37.
1,621 1,618	A, less than 18,000 J, 18,050	2 10		2 10	.....	Velocities and pressures taken by Lieut. O. M. Lissak, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer. Accepted.
1,745 1,720	A, 28,045 J, 29,300	3 0		2 8	Copper cylinders of 24,000 pounds initial compression and tables of 1890.	
90+1½°						

Record of firing with 10-inch B. L. rifle (cast iron), wire wound,

[Object of firing,

Date.	Kind of powder.	No. of prisms.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore	Elevation.
					Lbs. Oz.		*Lbs.*	*Inches.*	° ′
Jan. 7	Du Pont's brown prismatic V. C.; density, 1,830. Received Jan. 5, 1892. Lot 3.	1,527 7	39	.....	140 0	Cored shot, lot 188.	455 natural weight.	226.55	0 10
Jan. 7		875	40	Front cartridge.	80 0		454 natural weight.	226.55	0 10
		871		Rear cartridge.	80 0				
		7			160 0				
Jan. 8		1,520	41		140 0		452 natural weight.	226.55	0 15
Jan. 8	Lot 4.	873	42	Front cartridge.	80 0		451 natural weight.	226.55	0 15
		866		Rear cartridge.	80 0				
		7			160 0				
Jan. 8		873	43	Front cartridge.	80 0		454 natural weight.	226.55	0 15
		869		Rear cartridge.	80 0				
		7			160 0				
Jan. 8	Lot 3.	876	44	Front cartridge.	80 0		456 natural weight.	226.55	0 15
		869		Rear cartridge.	80 0				
		7			160 0				

Record of firing with 10-inch B. L. rifle (cast iron), wire wound,

[Object of firing,

Kind of powder.	No. of prisms.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore.	Elevation.
				Pounds.		*Pounds.*	*Inches.*	° ′
Du Pont's brown prismatic V. C., lot 5; density, 1,835; 43 prisms in cross section. Received June 19, 1891.	Brown..1,523 Black... 7	45	.....	140	Cored shot, lot 188.	454 natural weight.	227.45	0 25
	Brown....822 Brown....815 Black..... 5	46	Front cartridge. Rear cartridge..	75 75 / 150		453 natural weight.	227.50	0 25
	Brown....875 Brown....868 Black..... 7	47	Front cartridge. Rear cartridge..	80 80 / 160		454 natural weight.	227.45	0 25

Watervliet Arsenal, at Sandy Hook, N. J., January 7 and 8, 1892.

to prove powder.]

Instrumental velocity, 165 feet from muzzle.	Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.	*Pounds.*	*Ft. In.*	From right and rear 55°, 28 miles an hour.	*Ft. In.*		
Lost	N, 27,200 O, 26,040	2 8		2 8	Carriage 3½ inches out of battery when gun was fired.	
1,807 1,812	P, 30,277 R, 31,824	.....		.....	Carriage 1½ inches out of battery when gun was fired. Indicator failed to register recoil.	Gun mounted on barbette carriage. Obturating electric primers. Fired to sea.
1,708 1,698	N, 24,133 O, 24,260	3 0		2 10	Carriage 2½ inches out of battery when gun was fired.	Copper cylinders of 24,000 pounds initial compression and tables of 1890 used in rounds 39 to 42, inclusive.
1,835 1,830	N, 31,825 O, 30,960	2 10	From right and rear 45°, 6 miles an hour.	2 10	Carriage 1 inch out of battery when gun was fired.	Copper cylinders of 28,000 pounds initial compression and tables of 1890 used in rounds 43 and 44.
1,829 1,824	N, 30,500 O, 30,420	2 10		2 10	Carriage 1 inch out of battery when gun was fired. First velocity frame blown down by blast.	Velocities and pressures taken by Lieut. O. M. Lissak, Ordnance Department. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, assistant proof officer,
1,831 Lost.	N, 29,900 O, 31,660	3 0		3 0	Carriage 1 inch out of battery when gun was fired. Cylinders leaked considerably at rear stuffing-box after this round.	Lots 3 and 4 accepted.
$90+\frac{15}{2}^{0}$						

Watervliet Arsenal, at Sandy Hook, N. J., January 21, 1892.

to prove powder.]

Instrumental velocity, 200 feet from muzzle.	Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.	*Pounds.*	*Ft. In.*	From rear and right 15°, 20 miles an hour.	*Ft. In.*		
1,692 1,689	N, 27,800 O, 27,300	2 4		2 6	Carriage 2 inches out of battery when gun was fired. Copper cylinders of 1,800 pounds initial compression and tables of 1890.	Gun mounted on barbette carriage. Cylinder filled with oil before firing. Obturating friction primers. Fired into sand butt. Copper cylinders 24,000 pounds initial compression and tables '90 used in rounds 46, 47.
1,764 1,759	N, 28,420 O, 28,900	2 6½		2 6½	.....	Cylinder leaked considerably at rear stuffing box during firing. Velocities and pressures taken by Lt. O. M. Lissak, Ordnance Dept.
1,843 1,826	N, 31,620 O, 31,166	2 10		2 10	Escape of gas around threads of primer. Stay pin through rotating handle broken.	Firing conducted by Lt. O. M. Lissak, Ordnance Department, assistant proof officer. Gun turned over to testing board. Lot 5 accepted.
$125+\frac{15}{2}^{0}$						

Record of firing with 10-inch B. L. rifle (cast iron), wire wound,

[Object of firing, to test

Date.	Kind of powder.	Number of prisms.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.
				Kind.	Weight.	Kind.	Weight.		
P. M.					*Pounds.*		*Pounds.*	*Inches.*	° ′
Mar. 11	Du Pont's brown prismatic V. C., lot 2; density, 1.825; 43 prisms in cross section.	Brown..865 Brown..858 Black... 7	48	Front cartridge. Rear cartridge..	80 80 160	Cored shot, lot 188.	447 3 sand. 450	226.55	1 25
Mar. 11		Brown..865 Brown..858 Black... 7	49	Front cartridge. Rear cartridge..	80 80 160		450 natural weight.	226.55	1 30
Mar. 11		Brown..865 Brown..858 Black... 7	50	Front cartridge. Rear cartridge..	80 80 160		450 natural weight.	226.55	1 30
Mar. 11		Brown..865 Brown..858 Black... 7	51	Front cartridge. Rear cartridge..	80 80 160		445 5 sand. 450	226.55	1 25
Mar. 11		Brown..865 Brown..858 Black... 7	52	Front cartridge. Rear cartridge..	80 80 160		453 natural weight.	226.55	1 15
Mar. 11		Brown..865 Brown..858 Black... 7	53	Front cartridge. Rear cartridge..	80 80 160		453 natural weight.	226.55	1 35
Mar. 15		Brown..865 Brown..858 Black... 7	54	Front cartridge. Rear cartridge..	80 80 160		454 natural weight.	.....	1 30
Mar. 15		Brown..865 Brown..858 Black... 7	55	Front cartridge. Rear cartridge..	80 80 160		453 natural weight.	.....	1 15
Mar. 15		Brown..865 Brown..858 Black... 7	56	Front cartridge. Rear cartridge..	80 80 160		454 natural weight.	.....	1 15
Mar. 15		Brown..865 Brown..858 Black... 7	57	Front cartridge. Rear cartridge..	80 80 160		451 natural weight.	.....	1 15
Mar. 15		Brown..865 Brown..858 Black... 7	58	Front cartridge. Rear cartridge..	80 80 160		452 natural weight.	.....	1 15
Mar. 15		Brown..865 Brown..858 Black... 7	59	Front cartridge. Rear cartridge..	80 80 160		453 natural weight.	.....	1 15
Mar. 15		Brown..865 Brown..858 Black... 7	60	Front cartridge. Rear cartridge..	80 80 160		450 natural weight.	.....	1 15
Mar. 15		Brown..865 Brown..858 Black... 7	61	Front cartridge. Rear cartridge..	80 80 160		449 natural weight.	.....	1 20
Mar. 15		Brown..865 Brown..858 Black... 7	62	Front cartridge. Rear cartridge..	80 80 160		450 natural weight.	.....	1 15

Watervliet Arsenal, at Sandy Hook, N. J., March 11 and 15, 1892.

gun for endurance.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Ft. In.*		*Ft. In.*		
J, 27,040.... Navy, 30,380.	4 6	From rear 180°, 45 miles an hour.	4 6	.....	Gun mounted on barbette carriage. Obturating friction primers. Fired to sea.
J, 29,415.... Navy, 29,550.	4 8		4 6	.....	Depth of oil in cylinder, 5½ inches. Before this firing a new stay pin fitted to rotating handle.
J, 30,760.... Navy, 30,000.	4 8		4 8	.....	Console flew open and closed again after each discharge. Leakage of oil at rear cylinder head.
J, 30,985	4 9		4 6	.....	Copper cylinders of 24,000 pounds initial compression and tables of 1890 used in J gauge.
Navy, 31,400 ..	4 8		4 4	.....	Copper cylinders of 28,000 pounds initial compression and tables of 1890 used in Navy gauge.
J, 31,380.....	4 6		4 6	.....	Firing conducted by the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
J, 29,835.....	4 8		4 8	.....	
.....	4 11		4 11	.....	
.....	4 11		4 11	.....	Gun mounted on barbette carriage. Obturating friction primers. Three gallons of oil put in cylinder before firing; depth of oil in cylinder, 6¼ inches. Fired to sea. Console flew open and closed again after each discharge. Leakage of oil at rear cylinder head. Chamber sponged out after each round.
.....	4 10	From rear 180°, 10 miles an hour.	4 0	One gallon of oil added to cylinder, increasing depth to 7 inches. An old crack in upper strap, near front of cylinder, increased in length about 1½ inches in this round.	
.....	4 0		3 0	Bolts in rear cylinder head tightened.	Copper cylinders of 24,000 pounds initial compression and tables of 1890. Firing conducted by the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
J, 30,820.....	4 8		8 0	.....	
.....	4 8		2 0	.....	
.....	4 10		1 6	.....	
.....	4 9		.....	.....	

Record of firing with 10-inch B. L. rifle (cast iron), wire wound,

[Object of firing, to test

Date.	Kind of powder.	Number of prisms.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.
				Kind.	Weight.	Kind.	Weight.		
P. M.					*Pounds.*		*Pounds.*	*Inches.*	° ′
Mar. 30	Du Pont's brown prismatic V. C., lot 2; density, 1.825; 43 prisms in cross section.	Brown..865 Brown..858 Black... 7	63	Front cartridge. Rear cartridge..	80 80 160	Cored shot, lot 188.	448 natural weight.	226.75	1 30
Mar. 30		Brown..865 Brown..858 Black... 7	64	Front cartridge. Rear cartridge..	80 80 160		451 natural weight.	226.75	1 30
Mar. 30		Brown..865 Brown..858 Black... 7	65	Front cartridge. Rear cartridge..	80 80 160		450 natural weight.	226.75	1 30
Mar. 30		Brown..865 Brown..858 Black... 7	66	Front cartridge. Rear cartridge..	80 80 160		450 natural weight.	226.75	1 30
Mar. 31		Brown..865 Brown..858 Black... 7	67	Front cartridge Rear cartridge..	80 80 160		453 natural weight.	226.75	1 30
Mar. 31		Brown..865 Brown..858 Black... 7	68	Front cartridge. Rear cartridge..	80 80 160		450 natural weight.	226.75	1 30
Mar. 31		Brown..865 Brown..858 Black... 7	69	Front cartridge Rear cartridge..	80 80 160		451 natural weight.	226.75	1 30
Mar. 31		Brown..865 Brown..858 Black... 7	70	Front cartridge. Rear cartridge..	80 80 160		450 natural weight	226.75	1 30
Mar. 31		Brown..865 Brown..858 Black... 7	71	Front cartridge. Rear cartridge..	80 80 160		450 natural weight.	226.75	1 30
Mar. 31		Brown..865 Brown..858 Black... 7	72	Front cartridge. Rear cartridge..	80 80 160		450 natural weight.	226.75	1 30
Mar. 31	Du Pont's brown prismatic V. C.; density, 1.835. Lot 2.	Brown..865 Brown..858 Black.....7	73	Front cartridge. Rear cartridge..	80 80 160		449 natural weight.	226.25	1 30
A. M. Apr. 1		Brown..865 Brown..858 Black.....7	74	Front cartridge. Rear cartridge..	80 80 160		449 natural weight.	226.25	1 30
Apr. 1	Lot 5.	Brown..874 Brown..867 Black.....7	75	Front cartridge. Rear cartridge..	80 80 160		450 natural weight.	226.25	1 30
Apr. 1		Brown..874 Brown..867 Brown....7	76	Front cartridge. Rear cartridge..	80 80 160		451 natural weight.	226.25	1 30

Watervliet Arsenal, at Sandy Hook, N. J., from March 30 to April 1, 1892.

gun for endurance.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Ft. In.*		*Ft. In.*		
V, 31, 280	4 4	From front and left 15°, 5 miles an hour; March 31, from front and right 10°, 5 miles an hour.	4 3	Primer failed. Wires of primer pulled out. Brass vent shield very badly bent, and had to be cut off near stud before block could be opened.	Gun mounted on barbette carriage. Obturating friction primers. Since last firing rear stuffing box packed with metal packing; new packing in cylinder head. Fired to sea. Leakage of oil at rear stuffing box of cylinder. Vent shield not used during this firing. Difficulty in opening breech-block due to arc for rotating gear being burred; the last three teeth badly burred.
.....	4 8		4 6	.....	
.....	4 8		4 6	Carriage 6 inches out of battery when gun was fired.	
.....	4 9		.....	Rear cartridge disarranged while being inserted. Replaced by new one.	
.....	4 7		4 0	One gallon of oil added to cylinder.	
V, 31, 850	4 8		4 0	Carriage 5 inches out of battery when gun was fired.	
V, 31, 790	4 9		4 0	.....	
.....	4 10		4 1	Carriage 6 inches out of battery when gun was fired.	
V, 29, 200	4 11		4 3	.....	
.....	5 0		4 4	.....	
.....	5 0	From front and left 15°, 8 miles an hour.	4 0	.....	Gun mounted on barbette carriage. Obturating friction primers. One gallon of oil added to cylinder before firing. Before this firing arc for rotating gear smoothed down and burrs removed, mushroom head tightened, and rear gas-check cup filed and smoothed. Fired to sea. Chamber sponged out after each round to facilitate loading of projectile. Copper cylinders of 28,000 pounds initial compression and tables of 1890.
.....	4 8		4 0	First primer exploded, but failed to ignite charge.	
V, 31,930	4 7		4 0	.....	
V, 32,600	4 6		4 0	Carriage 6 inches out of battery when gun was fired.	

Record of firing with 10-inch B. L. rifle (cast iron), wire wound,

[Object of firing, to test

Date.	Kind of powder.	Number of prisms.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.
				Kind.	Weight.	Kind.	Weight.		
A. M.					*Pounds.*		*Pounds.*	*Inches.*	° ′
Apr. 1	Du Pont's brown prismatic V. C., lot 5; density, 1.835.	Brown..847 Brown..868 Black.....7	77	Front cartridge. Rear cartridge..	77 80 157	Cored shot, lot 188.	449 natural weight.	226.75	1 30
Apr. 1		Brown..847 Brown..868 Black.....7	78	Front cartridge. Rear cartridge..	77 80 157		455 natural weight.	226.75	1 30
Apr. 1		Brown..847 Brown..867 Black.....7	79	Front cartridge. Rear cartridge..	77 80 157		452 natural weight.	226.75	1 35
Apr. 1		Brown..843 Brown..868 Black.....7	80	Front cartridge. Rear cartridge..	77 80 157		450 natural weight.	226.75	1 35
Apr. 1		Brown..844 Brown..867 Black.....7	81	Front cartridge. Rear cartridge..	77 80 157		453 natural weight.	226.75	1 35
Apr. 1		Brown..845 Brown..867 Black.....7	82	Front cartridge. Rear cartridge..	77 80 157		456 natural weight.	.....	1 35
Apr. 1		Brown..843 Brown..888 Black... 7	83	Front cartridge. Rear cartridge..	77 80 157		456 natural weight.	226.75	1 30
Apr. 1		Brown..844 Brown..888 Black... 7	84	Front cartridge. Rear cartridge..	77 80 157		449 natural weight.	226.75	1 30
Apr. 1		Brown..844 Brown..868 Black... 7	85	Front cartridge. Rear cartridge..	77 80 157		451 natural weight.	226.75	1 35
Apr. 1		Brown..844 Brown..868 Black... 7	86	Front cartridge. Rear cartridge..	77 80 157		450 natural weight.	226.75	1 00
Apr. 1		Brown..844 Brown..868 Black... 7	87	Front cartridge. Rear cartridge..	77 80 157		452 natural weight.	226.75	1 00
Apr. 1	Du Pont's brown prismatic V. C., lot 5; density, 1.835; 43 prisms in cross section.	Brown..844 Brown..868 Black... 7	88	Front cartridge. Rear cartridge..	77 80 157		445 natural weight.	226.75	1 00
Apr. 1		Brown..844 Brown..868 Black... 7	89	Front cartridge. Rear cartridge..	77 80 157		450 natural weight.	226.75	1 00
Apr. 1		Brown..844 Brown..868 Black... 7	90	Front cartridge. Rear cartridge..	77 80 157		449 natural weight.	226.75	1 00

Watervliet Arsenal, at Sandy Hook, N. J., April 1, 1892.

gun for endurance.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Ft. In.*		*Ft. In.*		
V, 30,230	4 10	From front and left 15°, 8 miles an hour.	4 0		
.....	4 10		4 0		Gun mounted on barbette carriage. Obturating friction primers. One gallon of oil added to cylinder before firing.
.....	4 10		4 0		Before this firing arc for rotating gear smoothed down and burrs removed mushroom head tightened and rear gas-check cup filed and smoothed. Fired to sea, Chamber sponged out after each round to facilitate loading of projectile. Copper cylinders of 28,000 pounds initial compression and tables of 1890.
.....	4 10		.....	.....	
.....	4 10		1 0	Half gallon of oil added to cylinder.	
.....	4 9		2 0	One gallon of oil added to cylinder, increasing depth to 7 inches.	
V, 30,580	4 10		4 0		
.....	4 10		4 0		
.....	4 6		1 0		
.....	4 8		1 0		
.....	4 9		2 0		Gun mounted on barbette carriage. Obturating friction primers. Escape of gas around threads of primer. Chamber sponged out after each round. Fired to sea. Copper cylinders of 28,000 pounds initial compression and tables of 1890.
.....	4 10		3 0		
V, 29,310	4 10		3 0	Copper washer and first three threads of gauge cut by gas.	
.....	5 0		1 0		

Record of firing with 10-inch B. L. rifle (cast iron), wire wound,

[Object of firing, to test

Date.	Kind of powder.	Number of prisms.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.
				Kind.	Weight.	Kind.	Weight.		
A. M.					*Pounds.*		*Pounds.*	*Inches.*	° ′
Apr. 1	Du Pont's brown prismatic V. C., lot 5; density, 1.835; 43 prisms in cross section.	Brown..844 Brown..868 Black... 7	91	Front cartridge. Rear cartridge..	77 80 157	Cored shot, lot 188.	449 natural weight.	226.75	1 00
Apr. 1		Brown..844 Brown..868 Black... 7	92	Front cartridge. Rear cartridge..	77 80 157		453 natural weight.	226.75	1 00
Apr. 1		Brown..844 Brown..867 Black... 7	93	Front cartridge. Rear cartridge..	77 80 157		449 natural weight.	226.75	1 00
Apr. 1		Brown..844 Brown..867 Black... 7	94	Front cartridge. Rear cartridge..	77 80 157		449 natural weight.	226.75	1 00
Apr. 5		Brown..844 Brown..867 Black... 7	95	Front cartridge. Rear cartridge..	77 80 157		453 natural weight.	226.25	1 00
Apr. 5		Brown..844 Brown..867 Black... 7	96	Front cartridge. Rear cartridge..	77 80 157		450 natural weight.	226.25	1 00

[Object of firing, to

P. M.									
Apr. 5	Du Pont's brown prismatic V. C., lot 5; density, 1.835.	Brown..844 Brown..867 Black... 7	97	Front cartridge. Rear cartridge..	77 80 157	Cored shot, lot 188.	447 natural weight.	.....	1 30
Apr. 5		Brown..844 Brown..867 Black... 7	98	Front cartridge. Rear cartridge..	77 80 157		447 natural weight.	.....	1 30
Apr. 5		Brown..844 Brown..867 Black... 7	99	Front cartridge. Rear cartridge..	77 80 157		447 natural weight.	.....	1 30
Apr. 5		Brown..844 Brown..867 Black... 7	100	Front cartridge. Rear cartridge..	77 80 157		449 natural weight.	.....	1 30
Apr. 5		Brown..844 Brown..867 Black... 7	101	Front cartridge. Rear cartridge..	77 80 157		450 natural weight.	.....	1 30
Apr. 5		Brown..844 Brown..867 Black... 7	102	Front cartridge. Rear cartridge..	77 80 157		449 natural weight.	.....	1 30

Watervliet Arsenal, at Sandy Hook, N. J., April 1 and 5, 1892.

gun for endurance.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Ft. In.*		*Ft. In.*		
.....	5 0	From front and left 15°, 8 miles an hour.	1 0	Difficulty in removing primer.	Obturating friction primers. Escape of gas around threads of primer. Chamber sponged out after each round. Fired to sea. Copper cylinders of 28,000 pounds initial compression and tables of 1890.
.....	5 0		1 0	Threads of primer oiled....	
.....	4 11	.....	4 0	.....	
.....	5 0	.....	4 0	.....	Obturating friction primers. Chamber sponged out after each round. Leakage of oil at rear cylinder head. Fired to sea.
U, 31, 280.....	5 0	.....	4 4	First primer exploded, but failed to ignite charge. Escape of gas around threads of gauge. Two gallons of oil added to cylinder. Depth of oil measuring 6¼ inches.	Before firing, April 5, a new vent shield made of steel fitted to breechblock and seat for Zalinski sight secured to left trunnion. Gun star-gauged after round 94 by Lieut. O. M. Lissak, Ordnance Department.
.....	5 4	.....	5 0	.....	

test gun for rapidity.]

.....	5 4	.....	4 4	.....	
.....	5 4	.....	5 0	.....	Obturating friction primers. Escape of gas around threads of primers. Chamber sponged out after each round to facilitate loading of projectile. Fired to sea. Leakage of oil at rear cylinder head. Time occupied in firing 10 rounds, 1 hour 10 minutes. Time to be deducted for replacing block holding elevating screw, 6 minutes. Time to be deducted to allow ships to pass 9 minutes. Actual time, 55 minutes.
.....	5 0	.....	4 9	.....	
.....	5 4	.....	5 0	.....	
.....	5 4	.....	5 0	.....	
.....	5 3	.....	4 9	.....	

Record of firing with 10-inch B. L. rifle (cast iron), wire wound,

[Object of firing, to

Date.	Kind of powder.	Number of prisms.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.
				Kind.	Weight.	Kind.	Weight.		
P. M.					*Pounds.*		*Pounds.*	*Inches.*	° ′
Apr. 5	Du Pont's brown prismatic V. C., lot 5; density, 1.835.	Brown..844 Brown..867 Black... 7	103	Front cartridge. Rear cartridge..	77 80 157	Cored shot, lot 188.	450 natural weight.	.....	1 30
Apr. 5		Brown..844 Brown..867 Black... 7	104	Front cartridge. Rear cartridge..	77 80 157		449 natural weight.	.....	1 30
Apr. 5		Brown..844 Brown..867 Black... 7	105	Front cartridge. Rear cartridge..	77 80 157		450 natural weight.	.....	1 30
Apr. 5		Brown..844 Brown..867 Black... 7	106	Front cartridge. Rear cartridge..	77 80 157		450 natural weight.	.....	1 30

[Object of firing, to test

P. M.									
Apr. 5	Du Pont's brown prismatic V. C., lot 3; density, 1.840.	Brown..844 Brown..877 Black... 7	107	Front cartridge. Rear cartridge..	77 80 157	Cored shot, lot 188.	452 natural weight.	.....	1 30
Apr. 5		Brown..844 Brown..877 Black... 7	108	Front cartridge. Rear cartridge..	77 80 157		451 natural weight.	.....	1 30
Apr. 5		Brown..844 Brown..877 Black... 7	109	Front cartridge. Rear cartridge..	77 80 157		449 natural weight.	.....	1 30
Apr. 5		Brown..844 Brown..877 Black... 7	110	Front cartridge. Rear cartridge..	77 80 157		451 natural weight.	.....	1 30

Watervliet Arsenal, at Sandy Hook, N. J., April 5, 1892.

test gun for rapidity.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Ft. In.*		*Ft. In.*		
.....	5 1	.....	4 7	.....	Obturating friction primers. Escape of gas around threads of primers.
.....	5 0	.....	5 0	.....	Chamber sponged out after each round to facilitate loading of projectile. Fired to sea. Leakage of oil at rear cylinder head.
.....	4 11	.....	4 0	.....	Time occupied in firing 10 rounds, 1 hour 10 minutes. Time to be deducted for replacing block holding elevating screw, 6 minutes. Time to be deducted to allow ships to pass 9 minutes. Actual time, 55 minutes.
.....	4 11	.....	4 0	.....	

gun for endurance.]

U, 29,320	5 9	From rear and right 15°, 10 miles an hour.	4 9	.....	Obturating friction primers. Chamber sponged out after each round. Fired to sea.
.....	5 7		0 5	.....	Copper cylinder of 28,000 pounds initial compression and tables of 1890. Depth of oil measured after this firing, $4\frac{3}{4}$ inches in cylinder.
.....	5 8		0 5	Carriage 6 inches out of battery when gun was fired.	After this firing one strip of metal packing removed and asbestos inserted.
.....	5 9		0 5	.....	Firing conducted by the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department.

Record of firing with 10-inch B. L. rifle (cast iron), wire wound,

[Object of firing, to test

Date.	Kind of powder.	Number of prisms.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.	Deflection (points right).
				Kind.	Weight.	Kind.	Weight.			
A. M.					*Lbs.*		*Pounds.*	*Inches.*	° ′	
Apr. 6	Du Pont's brown prismatic V. C., lot 3; density, 1.840; 43 prisms in cross section.	Brown.844 Brown.877 Black.. 7	111	Front cartridge. Rear cartridge.	77 80 157	Cored shot, lot 188.	453 natural weight.	226.75	3 00	.....
Apr. 6		Brown.844 Brown.877 Black.. 8	112	Front cartridge. Rear cartridge.	77 80 157		447 natural weight.	226.75	3 00	.....
Apr. 6		Brown.844 Brown.877 Black.. 7	113	Front cartridge. Rear cartridge.	77 80 157		448 natural weight.	226.75	3 00	.....
Apr. 6		Brown.844 Brown.877 Black.. 7	114	Front cartridge. Rear cartridge.	77 80 157		449 natural weight.	226.75	3 00	.....
Apr. 6		Brown.844 Brown.877 Black.. 7	115	Front cartridge. Rear cartridge.	77 80 157		449 natural weight.	226.75	3 00	.....
Apr. 6		Brown.844 Brown.877 Black.. 7	116	Front cartridge. Rear cartridge.	77 80 157		451 natural weight.	226.75	3 00	.....
Apr. 6		Brown.844 Brown.877 Black.. 7	117	Front cartridge. Rear cartridge.	77 80 157		449 natural weight.	226.75	3 00	.....
Apr. 6		Brown.844 Brown.877 Black.. 7	118	Front cartridge. Rear cartridge.	77 80 157		449 natural weight.	226.75	3 00	.....
P. M. Apr. 6	Du Pont's brown prismatic V. C., lot 3; density, 1.840.	Brown.844 Brown.877 Black.. 7	119	Front cartridge. Rear cartridge.	77 80 157		448 natural weight.	226.75	3 00	½
Apr. 6		Brown.844 Brown.877 Black.. 7	120	Front cartridge. Rear cartridge.	77 80 157		447 natural weight.	226.75	3 00	⅝
Apr. 6		Brown.844 Brown.877 Black.. 7	121	Front cartridge. Rear cartridge.	77 80 157		448 natural weight.	226.75	3 00	½
Apr. 6		Brown.844 Brown.877 Black.. 7	122	Front cartridge. Rear cartridge.	80 77 157		447 natural weight.	226.75	3 00	½
Apr. 6		Brown 844 Brown.877 Black.. 7	123	Front cartridge. Rear cartridge.	80 77 157		447 natural weight.	226.75	3 00	½
Apr. 6		Brown.844 Brown.877 Black.. 7	124	Front cartridge. Rear cartridge.	80 77 157		447 natural weight.	226.75	3.00	½
Apr. 6		Brown.844 Brown.877 Black.. 7	125	Front cartridge. Rear cartridge.	80 77 157		448 natural weight.	226.75	3.00	½
Apr. 6		Brown.844 Brown.877 Black.. 7	126	Front cartridge. Rear cartridge.	80 77 157		447 natural weight.	226.75	3.00	½

Watervliet Arsenal, at Sandy Hook, N. J., April 6, 1892.

gun for accuracy.]

Pressure per square inch in bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Distance from center of target.				Distance from center of impact.				General remarks.
				Vertical.		Horizontal.		Vertical.		Horizontal.		
				Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
Pounds.	*Ft. In.*			*Ft. In.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	
U,30,245	4 7			4 0	...	7	0	0	.....	7.625	7.625	.....
.....	4 8			4 0	6	...	....	6	5.375	.....	1.625	.....
.....	4 9			4 0	...	3	....	6	.....	3.625	1.625	.....
.....	5 0			4 0	5	...	....	9	4.375	.....	.....	1.375
.....	5 0			4 0	0	0	....	5	.....	.625	2.625	.....
.....	5 0			4 0	0	0	....	3	.....	.625	4.625	.....
.....	5 0			4 0	0	0	....	16	.....	.625	.....	8.375
.....	5 0		From rear and right 40°, 11 miles an hour.	4 0	4	...	....	16	3.375	.....	.....	8.375
.....	4 9			4 6	2	...	....	6	6.25	.....	.....	3.375
.....	5 0			4 0	...	8	....	5	.....	3.75	.....	2.375
.....	5 0			4 0	...	1	....	13	3.25	.....	.....	10.375
.....	5 0			4 4	...	3	....	8	1.25	.....	.....	5.375
.....	5 0			5 0	...	2	....	2	2.25	.....	.625	.....
.....	5 0			4 2	5	...	....	13	9.25	.....	.....	10.375
.....	5 0			4 0	...	15	11	....	.....	10.75	13.625	.....
.....	5 0			4 0	...	12	15	....	.....	7.75	17.625	.....

Gun mounted on barbette carriage.
Obturating friction primers.
Fired at 3,000-yards target. Aimed at middle part of left edge.
Escape of gas around threads of primer.
Zalinski fortification artillery sight used.
First primer exploded, but failed to ignite charge.
Copper cylinder of 28,000 pounds initial compression and tables of 1890.
Five gallons of oil added to cylinder. Depth of oil measuring 6½ inches.

Center of impact: Feet.
Above ..... .625
Left 7.625
Mean vertical deviation from center of impact 3.28
Mean horizontal deviation from center of impact 4.53
Mean deviation from center of impact 5.59
Deviation of center of impact from plane of fire, right 9.67

Gun mounted on barbette carriage.
Obturating friction primers.
Fired at 3,000-yards target. Aimed at middle part of left edge.
Escape of gas around threads of primer.
Zalinski fortification artillery sight used.

Center of impact: Feet.
Below 4.25
Left 2.625
Mean vertical deviation from center of impact 5.56
Mean horizontal deviation from center of impact 7.968
Mean deviation from center of impact 9.715
Deviation of center of impact from plane of fire, right 10⅓

Record of firing with 10-inch B. L. rifle (cast iron), wire wound,

[Object of firing, to test

Date.	Kind of powder.	Number of prisms.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.	Deflection (points right).
				Kind.	Weight.	Kind.	Weight.			
A. M.					*Lbs.*		*Pounds.*	*Inches.*	° ′	
Apr. 8	Du Pont's brown prismatic V. C., lot 3; density, 1.840; 43 prisms in cross section.	Brown .884 Brown .877 Black .. 7	127	Front cartridge. Rear cartridge .	77 80 157	Cored shot, lot 188.	448 natural weight.	225.75	3.00	$\frac{1}{10}$
Apr. 8		Brown .844 Brown .877 Black .. 7	128	Front cartridge. Rear cartridge .	77 80 157		449 natural weight.	225.75	3.00	$\frac{1}{10}$
Apr. 8		Brown .844 Brown .877 Black .. 7	129	Front cartridge. Rear cartridge .	77 80 157		447 natural weight.	225.75	3.00	$\frac{1}{10}$
Apr. 8		Brown .844 Brown .877 Black .. 7	130	Front cartridge. Rear cartridge .	77 80 157		448 natural weight.	225.75	3.00	$\frac{1}{10}$
Apr. 8		Brown .844 Brown .877 Black .. 7	131	Front cartridge. Rear cartridge .	77 80 157		449 natural weight.	225.75	3.00	$\frac{1}{10}$
Apr. 8		Brown .844 Brown .877 Black .. 7	132	Front cartridge. Rear cartridge .	77 80 157		453 natural weight.	225.75	3.00	$\frac{1}{10}$
Apr. 8		Brown .844 Brown .877 Black .. 7	133	Front cartridge. Rear cartridge .	77 80 157		453 natural weight.	225.75	3.00	$\frac{1}{10}$
Apr. 8		Brown .844 Brown .877 Black .. 7	134	Front cartridge. Rear cartridge .	77 80 157		453 natural weight.	225.75	3.00	$\frac{1}{10}$

Watervliet Arsenal, at Sandy Hook, N. J., April 8, 1892.

gun for accuracy.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Distance from center of target.				Distance from center of impact.				General remarks.
				Vertical.		Horizontal.		Vertical.		Horizontal.		
				Above.	Below.	Right.	Left.	Above.	Below.	Right.	Left.	
Pounds.	*Ft. In.*		*Ft. In.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	*Ft.*	
U,30,480	4 9	From front and right 15°, 12 miles an hour.	4 0	6	...	9	....	10.625	.....	.....	3.625	Gun mounted on barbette carriage. Obturating friction primers. Fired at 3,000-yards target. Aimed at middle part of left edge. Escape of gas around threads of primer. Zalinski fortification artillery sight used. First primer exploded, but failed to ignite charge. Copper cylinders of 28,000 pounds initial compression and tables of 1890. Two and one-half gallons of oil added to cylinder. Depth of oil measuring 6½ inches. Center of impact: Feet. Below ..... 4.625 Right ..... 12.625 Mean vertical deviation from center of impact ..... 2.968 Mean horizontal deviation from center of impact ..... 2.218 Mean deviation from center of impact.... 3.705 Deviation of center of impact from plane of fire, right ..... 21 Firing conducted by the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department.
.....	5 0		4 0	6	...	9	....	.....	1.375	1.375	.....	
.....	5 0		4 0	4	...	14	....	.625	.....	1.375	.....	
.....	5 0		4 1	4	...	8	....	.625	.....	.....	4.625	
.....	4 9		4 0	5	...	14	....	.....	.375	1.375	.....	
.....	5 0		4 0	9	...	14	....	.....	4.375	1.375	.....	
.....	5 0		4 0	7	...	12	....	.....	2.375	.....	.625	
.....	5 0		4 1	8	...	16	....	.....	3.375	3.375	.....	

Record of firing with 10-inch B. L. rifle (cast iron), wire wound,

[Object of firing, to test

Date.	Kind of powder.	Number of prisms.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore.	Elevation.
A. M.					*Pounds.*		*Pounds.*	*Inches.*	° ′
May 12	Du Pont's brown prismatic V. C., lots 3, 4, and 5. Lot 3, density, 1.840; lot 4, density, 1.830; lot 5, density, 1.835; 43 prisms in cross section.		135	Lot 2	10	Cored shot, lot 188.	451 natural weight.	226	3 30
		Brown .845 Brown .870 Black .. 7		Lot 3	54				
				Lot 5	13				
				Front cartridge.	77				
				Rear cartridge..	80				
				Lot 3	157				
May 12		Brown .844 Brown .868 Black .. 7	136	Front cartridge.	77		452 natural weight.	226	1 45
				Lot 3					
				Rear cartridge..	80				
				Lot 5	157				
May 12			137	Lot 3	15		452 natural weight.	226	2 30
				Lot 4	62				
		Brown .843 Brown .869 Black .. 7		Front cartridge.	77				
				Rear cartridge..	80				
				Lot 3	157				
May 12		Brown .845 Brown .871 Black .. 7	138	Front cartridge.	77		452 natural weight.	226	2 45
				Lot 3					
				Rear cartridge..	80				
				Lot 3	157				
May 12		Brown .844 871 7	139	Front cartridge.	77		449 natural weight.	226	2 30
				Lot 3					
				Rear cartridge..	80				
				Lot 3	157				
May 12		Brown .844 Brown .870 Black .. 7	140	Front cartridge.	77		448 natural weight.	226	6 30
				Lot 3					
				Rear cartridge..	80				
				Lot 3	157				
May 12		Brown .842 Brown .867 Black .. 7	141	Front cartridge.	77		450 natural weight.	226	8 20
				Lot 4					
				Rear cartridge..	80				
				Lot 4	157				
May 12	Du Pont's brown prismatic V. C., lot 4; density, 1.830; 43 prisms in cross section.	Brown .843 Brown .868 Black .. 7	142	Front cartridge.	77		452 natural weight.	226	10 10
				Rear cartridge..	80				
					157				
P. M.									
May 12		Brown .842 Brown .868 Black .. 7	143	Front cartridge.	77		454 natural weight.	226	10 50
				Rear cartridge..	80				
					157				
May 12		Brown .842 Brown .868 Black .. 7	144	Front cartridge.	77		450 natural weight.	226	11 00
				Rear cartridge..	80				
					157				
May 12		Brown .842 Brown .868 Black .. 7	145	Front cartridge.	77		448 natural weight.	226	5 00
				Rear cartridge..	80				
					157				
May 12		Brown .842 Brown .869 Black .. 7	146	Front cartridge.	77		451 natural weight.	226	4 50
				Rear cartridge..	80				
					157				
May 12		Brown .842 Brown .867 Black .. 7	147	Front cartridge.	77		454 natural weight.	226	4 55
				Rear cartridge..	80				
					157				

Watervliet Arsenal, at Sandy Hook, N. J., May 12, 1892.

gun for endurance.]

Range.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Yards.	From right and rear, 3 miles an hour.	Carriage 2 inches out of battery when gun was fired.	Gun mounted on barbette carriage. Depth of oil in cylinder measured 6⅛ inches. Fired to sea. Obturating friction primers. Leakage of oil at rear cylinder head. Impressions taken of bore and shot chamber May 11, 1892. Erosions of considerable depth in slope of shot chamber; erosions of less depth at forward end of powder chamber and at beginning of rifling. Barometer, 29.91; thermometer, 62°; humidity, 66.
.....		Elevating screw broken off ..	
.....		.....	
.....		.....	
.....		.....

Record of firing with 10-inch B. L. rifle (cast iron), wire wound,

[Object of firing, to test

Date.	Kind of powder.	Number of prisms.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore.	Elevation.
P. M.					*Pounds.*		*Pounds.*	*Inches.*	° ′
May 12	Du Pont's brown prismatic V. C., lot 4; density, 1.830; 43 prisms in cross section.	Brown .842 Brown .868 Black .. 7	148	Front cartridge. Rear cartridge..	77 80 157	Cored shot, lot 188.	454 natural weight.	226	4 55
May 12		Brown .842 Brown .867 Black .. 7	149	Front cartridge. Rear cartridge..	77 80 157		450 natural weight.	226	4 55
May 12		Brown .842 Brown .869 Black .. 7	150	Front cartridge. Rear cartridge..	77 80 157		450 natural weight.	226	10 50
May 12		Brown .843 Brown .867 Black .. 7	151	Front cartridge. Rear cartridge..	77 80 157		448 natural weight.	226	10 55
May 12		Brown .843 Brown .867 Black .. 7	152	Front cartridge. Rear cartridge..	77 80 157		454	226	4 55
May 12		Brown .841 Brown .868 Black .. 7	153	Front cartridge. Rear cartridge..	77 80 157		450	226	4 55

[Object of firing,

P. M.									
June 22	Du Pont's brown prismatic V. C., lot 4; density, 1.830.	Brown .843 Brown .868 Black .. 7	154	Front cartridge. Rear cartridge..	77 80 157	Cored shot, lot 188.	447 natural weight.	.....	10 55
June 22		Brown .843 Brown .868 Black .. 7	155	Front cartridge. Rear cartridge..	77 80 157		452 natural weight.	.....	10 55
June 22		Brown .842 Brown .869 Black .. 7	156	Front cartridge. Rear cartridge..	77 80 157		455 natural weight.	.....	10 55
June 22		Brown .842 Brown .869 Black .. 7	157	Front cartridge. Rear cartridge..	77 80 157		449 natural weight.	.....	10 55
June 22		Brown .842 Brown .867 Black .. 7	158	Front cartridge. Rear cartridge..	77 80 157		455 natural weight.	.....	10 55
June 22		Brown .842 Brown .867 Black .. 7	159	Front cartridge. Rear cartridge..	77 80 157		452 natural weight.	.....	10 55
June 22		Brown .842 Brown .867 Black .. 7	160	Front cartridge. Rear cartridge..	77 80 157		452 natural weight.	.....	10 55
June 22		Brown .842 Brown .867 Black .. 7	161	Front cartridge. Rear cartridge..	77 80 157		452 natural weight.	.....	10 55

Watervliet Arsenal, at Sandy Hook, N. J., May 12 and June 22, 1892.

gun for endurance.]

Range.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Yards.	From right and rear, 3 miles an hour.		Gun mounted on barbette carriage. Obturating friction primers. Fired to sea. Firing conducted by Lieut. O. M. Lissak, Ordnance Department, in the presence of the testing board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department, of board for testing rifled cannon.
.....		.....	
.....		.....	
.....		.....	
.....		.....	
.....		.....	

to determine range.]

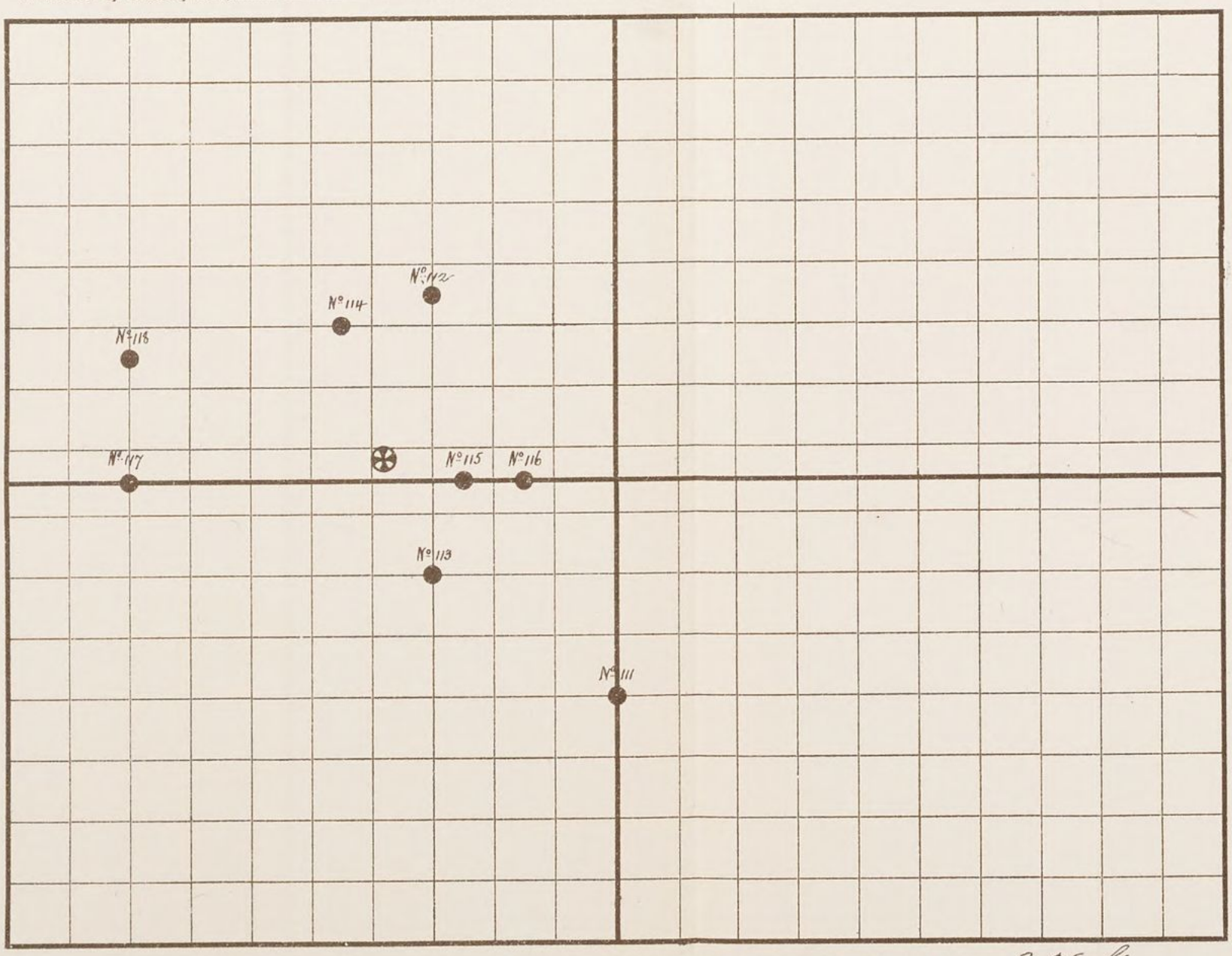
8,286	From rear, 10 miles an hour.	Carriage 1 inch out of battery when gun was fired.	
8,201		.....	
8,118		.....	Gun mounted on barbette carriage. Two gallons of oil added to cylinder. Oil measured 6⅜ inches at filling hole. Chamber sponged out after each round. Obturating friction primers.
8,192		.....	Fired to sea. Mean of five shots, 8,239 yards. Impressions of bore and shot-chamber taken September 19, 1892; scoring and guttering very marked about slope of shot-chamber.
8,087		.....	Firing conducted by Lieut. O. M. Lissak, Ordnance Department, in the presence of the testing board. Present: Capt. F. Heath, Ordnance Department; Lieut. O. M. Lissak, Ordnance Department.
8,164		.....	Lieut. O. M. Lissak observer at plane table on fort wall. Lieut. C. B. Wheeler observer at plane table near twin lights.
8,175		.....	
8,172		.....	
8,174 mean.			

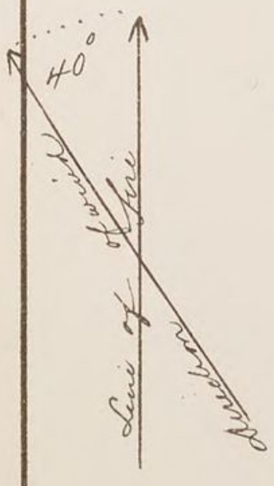
TARGET RECORD of 10" B.L. Rifle, Cast-iron, Wire wound

AT SANDY HOOK, N. J.
April 6th 1892

Target 3000 yards from Gun.

Number of shots fired, 8. Direct hits, 8. Ricochet hits, 0. Misses, 0.





Center of impact.

Point aimed at.

Mean vertical deviation from center of impact, 3.28 ft.

Mean horizontal deviation from center of impact, 4.53 ft.

Mean deviation from center of impact, 5.59 ft.

Target 30' × 40'.

Gun sighted by Lieut. W. W. Gibson, Ord. Dept.
Target observed by Sergt. W. C. Freeman, Ord. Detachment.

Appendix 42, 1892.

Wind 11 miles per hour.

Amond M. Lissak
Lieut. Ord. Dept. U.S.A.

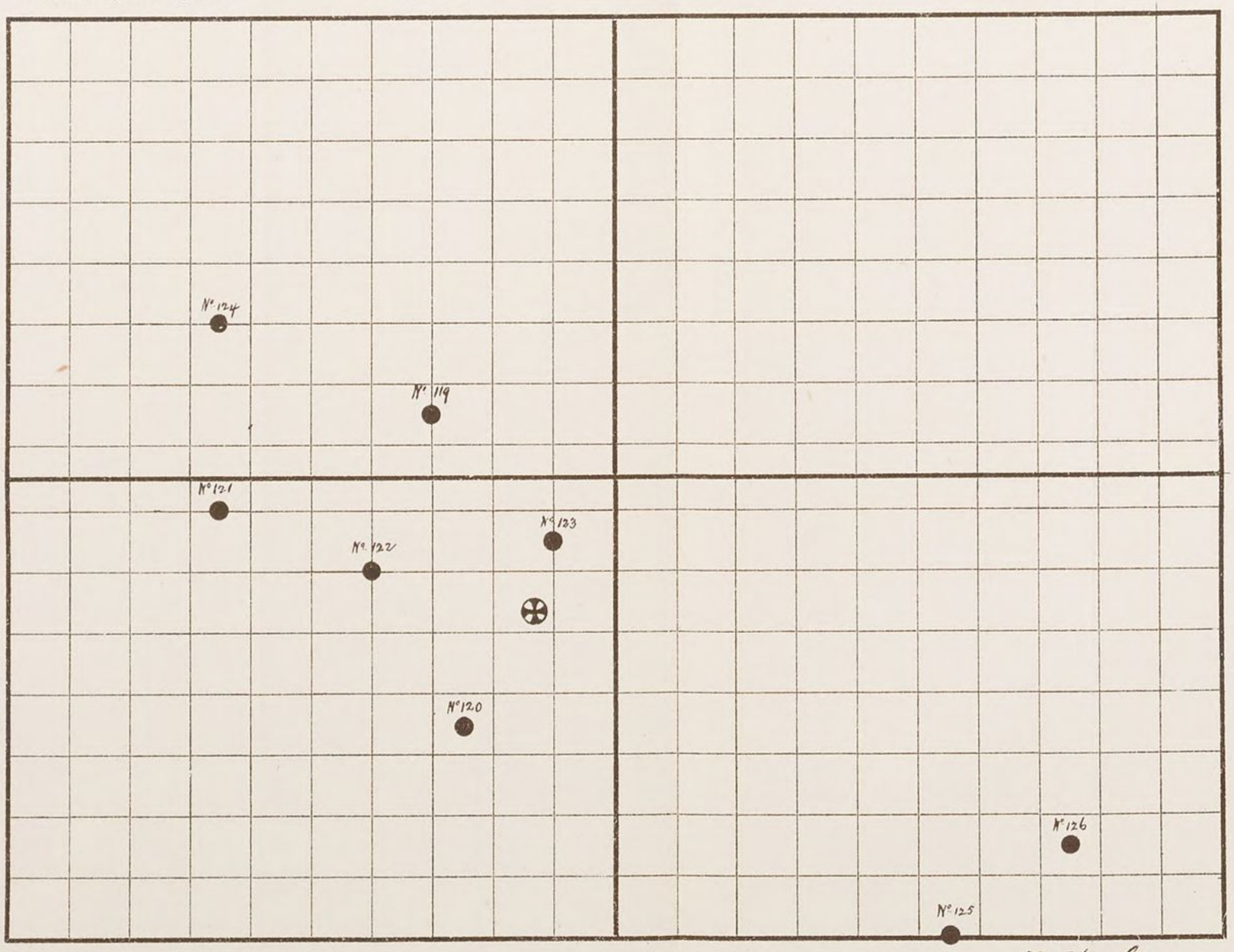
TARGET RECORD of 10" B.L. Rifle Cast-iron, Wire wound.

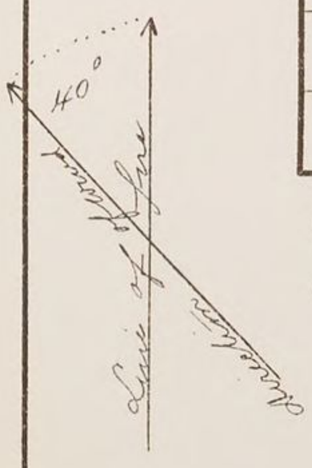
AT SANDY HOOK, N. J.

April 6 1892

Target 3000 yards *from Gun.*

Number of shots fired, 8 . *Direct hits,* 8 . *Ricochet hits,* 0 . *Misses,* 0 .





✠ *Center of impact.*

✠ *Point aimed at.*

Mean vertical deviation from center of impact, 5.56 ft.

Mean horizontal deviation from center of impact, 7.968 ft

Mean deviation from center of impact, 9.715 ft.

Target 30 × 40.

Gun sighted by Lieut. W. W. Gibson, Ord. Dept.
Target observed by Sergt. J. W. Warwick, Ord. Detachment.

Appendix 42, 1892.

Wind 11 *miles per hour.*

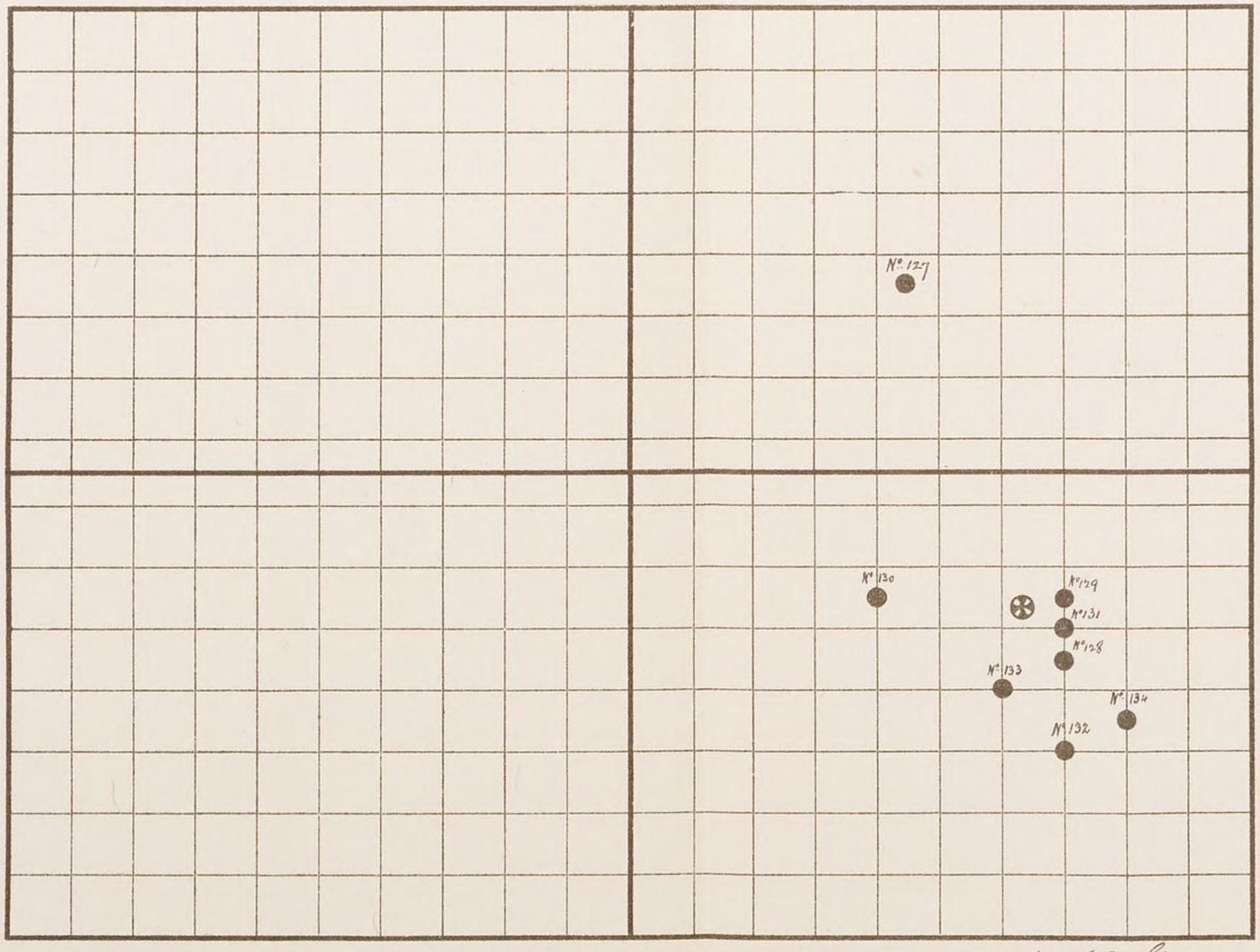
Lieut. Ord. Dept. U.S.

TARGET RECORD of 10" B.L. Rifle, Cast-Iron, Wire-Wound

AT SANDY HOOK, N. J.
April 8 1892

Target 2000 yds *from Gun.*

Number of shots fired, 8 . *Direct hits,* 8 . *Ricochet hits,* 0 . *Misses,* 0 .



✠ *Center of impact.*

✪ *Point aimed at.*

Mean vertical deviation from center of impact, 2.968 ft.

Mean horizontal deviation from center of impact, 2.218 ft.

Mean deviation from center of impact, 3.705 ft.

Target 30' × 40'.

Gun sighted by Lieut. W. H. Gibson, Ord.
Target observed by Sergt. W.C. Freeman, Ord. Detachment

Appendix 42, 1892.

Wind 12 *miles per hour.*

Lieut. Ord. Dept. U.S.A.

APPENDIX 43.

TEST OF EASTON & ANDERSON 12-INCH SPRING-RETURN MORTAR CARRIAGE.

(4 plates.)

THE ORDNANCE BOARD, U. S. ARMY.

NEW YORK ARSENAL,
GOVERNORS ISLAND, NEW YORK HARBOR,
New York City, August 16, 1892.

SIR: The following report on the test of the Easton & Anderson carriage for the 12-inch mortar is respectfully submitted:

This carriage is one of two ordered by the Department in England in the spring of 1889 for experimental purposes. It was manufactured by Messrs. Easton & Anderson, of Erith, Kent, from the patents of Lieut. Col. Raskazoff, of the Russian marine artillery, and is in design a modification of a carriage which had been successfully tried in Russia.

DESCRIPTION.

The mounting consists of a base ring or lower roller path 10 feet 5 inches in diameter to the center of the path, secured by twelve 1½-inch foundation bolts to a masonry foundation at a level of 3 feet 4½ inches below the floor level of the emplacement. The ring is of cast iron, composed of four segments truly fitted together, and the roller path is turned so as to serve both as a vertical support and lateral guide. Upon the base ring reposes a circle of twenty live rollers, originally of cast iron, now of forged steel, 9 inches in maximum diameter, securely held between two concentric frame rings furnished with double flanges, the object of which is to hold the upper portion of the mounting concentric with the base, and to take the lateral thrust resulting from the discharge. The base frame of the carriage is also of cast iron made in two parts, united together by means of bolts. On the lower side is formed a roller path truly turned and corresponding exactly to that on the base ring. The base frame is of cellular structure, and upon it is bolted a pair of cast-iron carriage sides, about 7 feet high, formed to receive the mortar and recoil apparatus.

The mortar has a range of elevation between 45 degrees and 75 degrees, and it recoils down slides placed at an angle of 60 degrees with the horizon. The slides are formed on the inner faces of the disk spring cases cast in the carriage sides. The cases are cylindrical, 8.8 inches in internal diameter, and inclined at an angle of 60 degrees with the horizon.

The slides are in form somewhat like the bed of a lathe, and the carriages which carry the trunnions of the mortar embrace them so as to be supported in every direction. The carriages, which are of cast steel, 3 feet 3 inches long, are provided with bearings for the trunnions, and with cap squares packed with elastic material introduced for the purpose of softening the shock in running up after recoil. The upper ends of the carriage have formed on them brackets projecting right and left into the spring cylinders. These rest on the upper ends of the piles of disk springs, and by that means transfer the weight of the mortar to them. The slides are slotted to allow these brackets to traverse down the full length of possible recoil, that is 2 feet 6 inches. The spring cases in the carriage sides are not sufficiently long to accommodate the requisite number of springs; they are, therefore, produced downwards by means of cast iron cylinders secured to the sides at their upper ends by means of flanges and bolts.

The power required to compress the springs is, however, not nearly so great as the energy of recoil and the work done by the falling gun; hence a pair of hydraulic cylinders are secured to the spring casings immediately below the trunnion carriages. These cylinders are of cast steel, 7½ inches in diameter, and are fitted with 3½-inch steel piston rods, which work through hemp-packed stuffing boxes at either end of the cylinders. The upper end of each rod is keyed into a socket formed in the carriage immediately under the trunnions, while about the middle of the rod a piston is formed out of the solid, and is an easy fit in the cylinder. A connecting passage is formed between the two ends of the cylinders; it enters the upper end immediately below the gland, and holes are bored at proper intervals connecting it with the cylinder. The upper face of the piston is recessed, and into the recess fits an annular piston, secured to the upper end of the cylinder. The force of the recoil is taken up by the resistance which the fluid offers to being driven through the holes, which are successively closed by the piston. At the end of the running up of the gun, on the other hand, the annular piston enters the recess in the main piston, and the water thus imprisoned is only able to escape by the windage. In this way the mortar is stopped quietly at the end of both motions. Plugs are provided for closing or partly closing the holes.

Cast-steel lateral guides are secured to the carriage sides and adjusted so as to bear against the body of the mortar at its breech end. By this means any tendency to move out of the vertical plane is counteracted.

The elevating gear consists of a wrought-iron circular rack secured to the mortar and to a hoop shrunk onto it just in front of the reinforcing hoops. A wrought-iron pinion gears into this rack, and is carried by a spindle working in bearings attached to one of the carriages. This wheel is driven by another pinion attached to the carriage in a similar manner, and at its outer end its spindle is fitted with a handwheel of convenient dimensions. The wheel on the rack spindle can be graduated on its face and an index attached to the carriage, which will enable the degrees of elevation to be read off. This gear is fitted to both sides of the mortar.

The traversing gear consists of a cast-iron annular, internally geared spur ring, attached by flanges and bolts to the base roller path. A 12-toothed shrouded pinion gears into this and is keyed onto the lower end of a spindle, which passes upwards through a long bearing bolted to the base frame of the carriage, and is supported also by a bracket bolted to the inner side of one of the carriage sides. The upper end of the spindle carries a worm wheel, which is geared into by a worm on a

horizontal shaft, which passes through the carriage sides and is fitted with winch handles supported by brackets bolted to the carriage sides at their outer faces.

To protect the edge of the masonry and also to furnish a large graduated circle for training, a cast-iron ring made in four segments is fitted to the edge of aperture in the floor in which the mounting works. It is held down by Lewis bolts with countersunk nuts, and has its horizontal face clearly graduated in degrees, a pointer being fixed to the top frame for the purpose of indicating the degrees of training.

The loading gear consists of a short tray carried on the end of a bow lever, the lower end of which is pivoted to one of the carriage sides. The pivot passes through the side and carries a lever, the upper end of which is fitted with a swiveling nut, through which works a diagonal screw spindle, extending to the front of the mounting, where it is supported in a suitable bearing and carries a handwheel, by operating which the shot is raised into a proper position for being rammed into the gun. For loading and cleaning the mortar will be brought to an angle of about 5 degrees elevation. The shot or shell is carried in a truck, which delivers it direct to the loading tray when the latter is depressed.

The height of the center of the trunnions above the floor of the emplacement when the gun is in the firing position is 4 feet 8 inches. There are no valves of any kind, and only glands to pack with hemp in the usual manner. The only care necessary in using the mounting is to see that the cylinders are full of fluid, which for a cold climate should be a mixture of methylated spirits, water, oil, and carbonate of soda.

In setting up the carriage the graduated training ring was not used and the platform was not built up around the carriage in order that access to the lower parts from the exterior might remain free.

The test of the carriage commenced in the summer of 1890 and it was speedily made apparent that the Belleville springs were entirely too weak to perform their office; they would neither return the piece to the firing position after recoil nor hold it there after it had been returned by other means. In all other respects the carriage worked admirably; the loading, traversing, and elevating were performed with ease and promptness.

Pending the result of efforts to get stronger springs from the manufacturers the firing was continued under the following conditions: The springs were compressed by the insertion of additional pairs and the setting down of the screws provided for the purpose, until they would support the piece within an inch or two of the firing position, to which position it was raised after each round by a hydraulic jack. The recoil was reduced to 20 inches by closing and partly closing with plugs the orifices for the flow of the liquid in the hydraulic cylinders, in order not to overcompress the springs and give them increased set. A charge of powder (60 pounds) was determined, which, with this diminished recoil, would strain the recoil-checking appliances as strongly as the full charge of 80 pounds with the full recoil of 30 inches. Under these conditions the carriage endured well until the piece was fired at elevation of 45 degrees, when it failed, first by the breaking of the flanges of the cast-iron rollers, which were replaced by forged steel ones, second by the breaking of all of the holding-down bolts of the outer row, which were replaced by new bolts, their number being increased from eight to twelve, and the inner row of bolts being removed, as being useless on account of their insufficient hold in the masonry, and finally

by the breaking off of one of the slides supporting the right trunnion carriage from the side frame on which it was cast, due to the lateral component of the powder pressure.

The carriage was then (in May, 1891) sent to the works of the Builders' Iron Foundry, at Providence, R. I., and new side frames and trunnion carriages were made in which the slides were strengthened and the carriages were given bearing on both slides at all angles of elevation. (See Figs. 1 and 2, Pl. II.) It was received back and came into the hands of this board in March last, together with a new set of Belleville springs from Messrs. Easton & Anderson.

One hundred and twenty-three and one-half pairs of the new springs (all there were) and three pairs of the old ones were placed in each spring cylinder, and firing recommenced with the repaired carriage in accordance with the following programme:

PROGRAMME.

One round to be fired with charge of 15 pounds at elevation of 60 degrees to see if parts are properly adjusted.

One round to be fired at elevation of 60 degrees with each of the charges 40, 60, 70, and 80 pounds.

One round to be fired with charge of 80 pounds at each of the angles of elevation, 65, 70, 73 degrees.

Five rounds to be fired with charge of 80 pounds at elevation 75 degrees.

One round to be fired with charge of 80 pounds at each of the angles of elevation 55, 50, 47 degrees.

Ten rounds to be fired with charge of 80 pounds at elevation 45 degrees.

The length of recoil and counter recoil to be noted after each round and the plugs in the recoil cylinders to be so disposed as not to permit the former to exceed 25 inches.

From the first the springs failed signally to return the piece to the firing position, and under the impression that this might be due to the closeness of their fit in the spring cylinders they were taken out and reduced in a lathe to the uniform exterior diameter of 8.7 inches, that of the cylinders being about 8.8 inches.

Upon recommencing firing in accordance with the original programme no amelioration was apparent, the springs not only failing by as much as 12 inches to return the piece to the firing position, but soon commencing to allow it to drop back after it had been raised with a jack. This was held to demonstrate their inefficiency, at least with the length of recoil allowed, and no further effort was made at this time to have them raise the piece. The firing was, however, continued in order to test the other features of the carriage, the piece being raised after each discharge by a jack, and the springs being compressed by the screw plugs only sufficiently to hold the piece within 2 or 3 inches of the proper firing position, at which place it could be loaded without difficulty, and from which it was fired. The recoil was brought down to about 20 inches. A charge giving the full service pressure was found to be 78 pounds of Du Pont's brown prismatic powder, R. H. B., lot 9.

The carriage acted well, with the exception noted, with firing at all angles of elevation except 45 degrees. At 75 degrees, when the lateral component of the powder pressure, which had produced the former break, was greatest, no evidence of weakness was apparent. But at 45 degrees the flanges of the rollers failed to keep the racer upon the bed plate and it was forced back until it rested upon the exterior flanges of the rear rollers, while the flanges of the front rollers rested upon the bed plate. No remedy was apparent for this difficulty, and

after having fired two rounds at 45 degrees the programme was completed by firing two rounds without incident at 48 degrees.

Early in the firing a piece was broken from the worm wheel in the traversing gear by the right trunnion carriage, which struck it in recoiling, owing to there not being sufficient clearance; during the remainder of the firing traversing was limited to a small angle. The chipping from the trunnion carriage of a small amount of metal would have prevented the accident had the necessity been observed in time.

The three points requiring test in the repaired carriage were, by the execution of the above programme, established as follows: (1) The strength of the slides was shown to be sufficient; (2) the springs would not return the piece to the firing position; (3) the flanges of the rollers would not retain the racer upon the bed plate when firing at angles less than 48 degrees.

The last point was not deemed of importance, as in the new carriages under manufacture horizontal motion of the racer is prevented by a pivot. But the second point is of moment, as upon it depends the successful working of this type of carriage, and it was considered necessary, the test of the strength and general efficiency having been completed, to make an effort to obtain satisfactory action in regard to it. To this end the following plan was adopted, viz: To compress the springs by the insertion of additional pairs and setting down the screw plugs until they would exercise sufficient effort to raise the piece to a position in which it could be loaded; to reduce the recoil as much as the strength of the parts of the hydraulic brakes would permit in order to avoid great overcompression of the springs.

In carrying out this programme, which was done gradually, the only difficulties encountered were the leakage in the joints of the pipe for equalizing the pressure in the hydraulic cylinders, and the bursting of its connections. All of the commercial fittings, which were of brass, had to be replaced by specially made iron or steel ones. The object sought was finally attained when the number of Belleville springs had been increased to 140½ pairs in each spring cylinder, of which 17 pairs were from the lot originally sent with the carriage; the compressing plugs had been set down 3 inches, and the recoil had been reduced to a length between 12 and 13 inches, the hydraulic pressure being then estimated to approximate 5,000 pounds per square inch. Under these conditions the piece returned after each discharge to the position from which it was fired, which was practically the position designed. Although the greatest strain upon the hydraulic apparatus is produced when firing at an elevation of 60 degrees, the angle used in working up to the final condition, a few rounds were fired with full charges and elevations varying from 48 degrees to 75 degrees.

The diagram in Fig. 3 of Pl. II represents the area of the orifices for the flow of the liquid in each hydraulic cylinder, the horizontal distances representing the travel of the piston. As stated above, this travel was finally limited to about 12½ inches, which was a little short of the position of the third hole. The area, 0.29 square inch, is due to the difference of 0.025 inch in the diameters of the piston and the cylinder. The diameter of the holes leading from the cylinder to the return passage is about 0.95 inch, and the plugs used to regulate their size were of the form shown in Fig. 4 of Pl. II.

It is seen that the first, fourth, fifth, sixth, and seventh holes were closed, the second three-quarters closed, and the third seven-eighths closed. In view of the extreme shortness of the recoil the carriage would have been better treated if a throttling bar, or some similar device,

had been used to make the orifices of flow vary regularly and in such manner as to produce a constant resistance. But on account of the device for checking gently the counter recoil the change would have necessitated the design and manufacture of a new set of hydraulic cylinders, and it was deemed better policy to take the slight risk of damage, especially as the carriage under test was not to be used for service.

The manufacture of Belleville springs is an industry not established in the United States, and since the character and performance of those used with this carriage constitute so vital a feature of the design the records of the test of the two lots used are forwarded herewith, the results being graphically shown in Pls. III and IV. In estimating the number to be used and the length of recoil to be permitted the qualities considered must be those which the springs exhibit after they have been subjected to great overcompression.

After the severe test which this carriage has undergone the board considers that it is fit for use in the service in every respect except that of firing at angles of elevation below 48 degrees, and, in view of the changes, favorable to the carriages, made in the design of the additional ones under manufacture, the opinion is expressed that they will perform satisfactorily.

Forty-eight rounds have been fired from the repaired carriage, of which thirty were with full charges.

CLIFTON COMLY,
Major, Ord. Dept., U. S. Army, President.
FRANK HEATH,
Captain, Ord. Dept., U. S. Army.
WILLIAM CROZIER,
Captain, Ord. Dept., U. S. Army.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

(2042–'92.)

REPORT OF MECHANICAL TESTS MADE WITH THE UNITED STATES TESTING MACHINE (CAPACITY 800,000 POUNDS) AT WATERTOWN ARSENAL, MASSACHUSETTS, JUNE 30, 1890.

Tests by compression.

[Five pairs of Belleville springs from the Easton & Anderson mortar carriage.]

[Total height of 5 pairs of springs under initial load of 500 pounds, 6.10 inches; total weight, 54½ pounds.]

Applied loads.	Compression.	Successive compression.	Compression set.	Applied loads.	Compression.	Successive compression.	Compression set.
Pounds.	*Inches.*	*Inches.*	*Inches.*	*Pounds.*	*Inches.*	*Inches.*	*Inches.*
*500	0	0	0	*500	0	0	0
4,000	.293	.293	.....	32,000	2.230	.090	.....
8,000	.600	.307	.....	36,000	2.285	.055	.....
12,000	.925	.325	.....	40,000	2.321	.036	.....
16,000	1.282	.357	.....	36,000	2.296	.025	.....
20,000	1.684	.402	.....	32,000	2.258	.038	.....
16,000	1.384	.300	.....	28,000	2.196	.062	.....
12,000	1.054	.330	.....	24,000	1.993	.203	.....
8,000	.719	.335	.....	20,000	1.814	.179	.....
4,000	.379	.340	.....	16,000	1.616	.198	.....
500	.....	.....	0.26	12,000	1.261	.355	.....
4,000	.326	.300	.....	8,000	.901	.360	.....
8,000	.637	.311	.....	4,000	.506	.395	.....
12,000	.95	.314	.....	500	.....	.....	.117
16,000	1.315	.364	.....	†12,000	1.051	.934	.....
20,000	1.690	.375	.....	‡11,900	.....	.....	.....
24,000	1.986	.296	.....	12,000	1.056	.005	.....
28,000	2.140	.154	.....	500	.....	.....	.113

* Initial load.
† Load left on springs Saturday night.
‡ Load on springs Monday morning, after 40 hours' rest.

[Loaded ten times with 40,000 pounds, releasing to 8,000 pounds between each maximum load. Under the tenth loading the springs remained 15 minutes.]

500	.....	.....	.163	36,000	2.300	.022	.....
4,000	.452	.289	.....	32,000	2.263	.037	.....
8,000	.777	.325	.....	28,000	2.204	.059	.....
12,000	1.094	.317	.....	24,000	2.111	.093	.....
16,000	1.471	.377	.....	20,000	1.949	.162	.....
20,000	1.835	.364	.....	16,000	1.667	.282	.....
24,000	2.061	.226	.....	12,000	1.316	.351	.....
28,000	2.181	.120	.....	8,000	.949	.367	.....
32,000	2.251	.070	.....	4,000	.561	.388	.....
36,000	2.293	.042	.....	500	.....	.....	.163
40,000	2.322	.029	.....				

A. L. VARNEY,
Captain, Ord. Dept., U. S. Army, Commanding.

REPORT OF MECHANICAL TESTS MADE WITH THE UNITED STATES TESTING MACHINE (CAPACITY 800,000 POUNDS) AT WATERTOWN ARSENAL, MASSACHUSETTS, MAY 8, 1891.

Tests by compression.

Five pairs Belleville springs from second lot received for the Easton & Anderson 12-inch mortar carriage from England.

Beginning with the initial load, 500 pounds, the springs were next loaded with 1,000 pounds, and with increments of 1,000 pounds thereafter until 50,000 pounds was reached. After applying 5,000 pounds and multiples thereof, the loads were released to the initial load and the sets observed. After once applying 50,000 pounds and releasing the load, micrometer observations were for the time being discontinued.

The springs were loaded ten times with 50,000 pounds, then followed another series of observations in which the load was advanced without releasing until 30,000 pounds was reached, then downward readings taken, showing the recovery as the loads were released, from which a comparison may be made of the ascending and descending paths of resistance. There were permanent sets displayed during the first series of loadings, which sets increased as higher loads were successively applied and released. The rate of compression was fairly uniform up to about 30,000 pounds, after which, although the springs were not closed down, the resistance increased, and between 45,000 and 50,000 pounds they were practically closed down. The repeated application of 50,000 pounds ten times increased the set from 0.1977 inch to 0.2853 inch. The behavior of the springs under the two series of loadings is shown as follows, the amount of compression alone being considered, disregarding the permanent set which existed at the commencement of the second series:

Applied loads.	Compression.			
	First series.	Second series.		
		Ascending loads.	Descending loads.	Differences.
Pounds.	*Inches.*	*Inches.*	*Inches.*	*Inch.*
500	Initial load.			
5,000	.2477	.2443	.3192	.0749
10,000	.5137	.5157	.6342	.1185
15,000	.7921	.7937	.9177	.1240
20,000	1.0793	1.0767	1.1780	.1013
25,000	1.3903	1.3527	1.3998	.0471
30,000	1.6859	1.5562	.....	.....

The springs compressed nearly the same after having been loaded ten times as when first loaded up to the load 25,000 pounds. In the second series the maximum load applied was 30,000 pounds, and descending readings were taken for the purpose of observing the behavior of the springs when loaded within limits in which the compressions were approximately proportional to the loads. The ascending and descending paths differed notwithstanding.

No. 5,281.

Weight of 5 pairs	pounds	66
Exterior diameter	do	8.73
Diameter of hole	do	2.37
Covexity (each spring)	do	.23
Thickness	do	.41
Height of 5 pairs under initial load	do	6.52

Applied loads.	Compression.		Permanent set.	Applied loads.	Compression.		Permanent set.
	Total.	Successive.			Total.	Successive.	
Pounds.	*Inches.*	*Inches.*	*Inch.*	*Pounds.*	*Inches.*	*Inches.*	*Inch.*
*500	0	0	0	*500	0	0	0
1,000	.0375	.0375	.....	6,000	.5837	.0541	.....
2,000	.0928	.0553	.....	7,000	.6380	.0543	.....
3,000	.1456	.0528	.....	8,000	.6916	.0536	.....
4,000	.1960	.0504	.....	9,000	.7455	.0539	.....
5,000	.2477	.0517	.0070	10,000	.8010	.0555	.....
6,000	.3004	.0527	.....	11,000	.8560	.0550	.....
7,000	.3531	.0527	.....	12,000	.9117	.0557	.....
8,000	.4060	.0529	.....	13,000	.9670	.0553	.....
9,000	.4598	.0538	.....	14,000	1.0211	.0541	.....
10,000	.5137	.0539	.0129	15,000	1.0790	.0579	.....
11,000	.5677	.0540	.....	16,000	1.1358	.0568	.....
12,000	.6230	.0553	.....	17,000	1.1910	.0552	.....
13,000	.6780	.0550	.....	18,000	1.2493	.0583	.....
14,000	.7342	.0562	.....	19,000	1.3050	.0557	.....
15,000	.7921	.0579	.0182	20,000	1.3620	.0570	.....
16,000	.8603	.0682	.....	21,000	1.4200	.0580	.....
17,000	.9073	.0470	.....	22,000	1.4770	.0570	.....
18,000	.9610	.0537	.....	23,000	1.5320	.0550	.....
19,000	1.0208	.0598	.....	24,000	1.5870	.0550	.....
20,000	1.0793	.0585	.0233	25,000	1.6380	.0510	.....
21,000	1.1375	.0582	.....	26,000	1.6858	.0478	.....
22,000	1.1981	.0606	.....	27,000	1.7290	.0432	.....
23,000	1.2603	.0622	.....	28,000	1.7700	.0410	.....
24,000	1.3253	.0650	.....	29,000	1.8092	.0392	.....
25,000	1.3903	.0650	.0355	30,000	1.8415	.0323	.....
†26,000	1.4463	.0560	.....	29,000	1.8060	.0355	.....
27,000	1.5071	.0608	.....	28,000	1.7880	.0180	.....
28,000	1.5693	.0622	.....	27,000	1.7570	.0310	.....
29,000	1.6287	.0594	.....	26,000	1.7220	.0350	.....
30,000	1.6859	.0572	.0412	25,000	1.6851	.0369	.....
31,000	1.7333	.0474	.....	24,000	1.6460	.0391	.....
32,000	1.7731	.0398	.....	23,000	1.6030	.0430	.....
33,000	1.8148	.0417	.....	22,000	1.5582	.0448	.....
34,000	1.8496	.0348	.....	21,000	1.5111	.0471	.....
35,000	1.8805	.0309	.0930	20,000	1.4633	.0478	.....
36,000	1.9059	.0254	.....	19,000	1.4127	.0506	.....
37,000	1.9340	.0281	.....	18,000	1.3612	.0515	.....
38,000	1.9447	.0107	.....	17,000	1.3099	.0513	.....
39,000	1.9614	.0167	.....	16,000	1.2568	.0531	.....
40,000	1.9771	.0157	.1407	‖15,000	1.2030	.0538	.....
41,000	1.9934	.0163	.....	14,000	1.1490	.0540	.....
42,000	2.0069	.0135	.....	13,000	1.0915	.0575	.....
43,000	2.0194	.0125	.....	12,000	1.0362	.0553	.....
44,000	2.0290	.0096	.....	11,000	.9780	.0582	.....
45,000	2.0369	.0079	.....	10,000	.9195	.0585	.....
46,000	2.0458	.0089	.....	9,000	.8572	.0623	.....
47,000	2.0539	.0081	.....	8,000	.7957	.0615	.....
48,000	2.0586	.0047	.....	7,000	.7330	.0627	.....
49,000	2.0641	.0055	.....	6,000	.6677	.0653	.....
‡50,000	2.0711	.0070	.1977	5,000	.6045	.0632	.....
§500	.....	.....	.2853	4,000	.5393	.0652	.....
1,000	.3183	.0330	.....	3,000	.4620	.0773	.....
2,000	.3713	.0530	.....	2,000	.4025	.0595	.....
3,000	.4250	.0537	.....	1,000	.3314	.0711	.....
4,000	.4773	.0526	.....	500	.2870	.0440	.2870
5,000	.5296	.0520	.....				

*Initial load. First series of readings.
†Rested under 5,000 pounds fourteen hours.
‡Loaded with 50,000 pounds ten times.
§Second series of readings.
‖Rested under load 30 minutes.

A. L. VARNEY,
Captain, Ord. Dept., U. S. Army, Commanding.

Record of firing with 12-inch B. L. mortar (cast iron) No. 1 (steel-hooped),

[Object of firing, test of Easton

Date.	No. of fire on carriage.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Travel of shot in bore.	Elevation.
				Lbs. Oz.		*Pounds.*	*Inches.*	° ′
A. M.			Du Pont's sphero-hexagonal O. X. C.; density, 1.795; granulation, 100.		Mortar shell, lot 329			
May 13	81	332		15 0		630 natural weight..	91.5	60 00
May 13	82	333		40 0		627 natural weight..	91.5	60 00
May 13	83	334		60 0		629 natural weight..	91.	60 00
P. M.								
May 26	84	335		15 0		630 natural weight..	91.5	60 00
May 26	85	336	Du Pont's sphero-hexagonal O. X. C.; density, 1.795; granulation, 100.	40 0		632 natural weight..	91.5	60 00
May 26	86	337		60 0		629 natural weight..	91.5	60 00
May 26	87	338		70 0 747 prisms brown; 7 prisms black.		629 natural weight..	91.5	60 00
A. M.								
May 27	88	339		80 0 852 prisms brown; 7 prisms black.		629 natural weight..	91.5	60 00
May 27	89	340	Du Pont's prismatic R. H. B., lot 9; density, 1.830.	78 0 839 prisms brown; 7 prisms black.		630 natural weight..	91.5	65 00
May 27	90	341		78 0 839 prisms brown; 7 prisms black.		630 natural weight..	91.5	70 00
May 27	91	342		78 0 840 prisms brown; 7 prisms black.		630 natural weight..	91.5	73 00
May 27	92	343		78 0 841 prisms brown; 7 prisms black.		630 natural weight..	91.5	75 00
May 27	93	344	Du Pont's brown prism 9; density	78 0 841 prisms brown; 7 prisms black.		630 natural weight..	91.5	75 00

South Boston Iron Works, at Sandy Hook, N. J., May 13 to 27, 1892.

Anderson carriage, repaired.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments etc., and metrological data.	General remarks.
Pounds.	*Inches.*		*Inches.*		
.....	$5\frac{5}{8}$	From right, 6 miles an hour.	$2\frac{1}{8}$	.....	Mortar mounted on Easton & Anderson carriage. Obturating friction primers. Fired down the beach. First, third, fifth, sixth, and seventh holes of cylinders closed; fourth half closed; second three-quarters closed. 30-ton hydraulic jack used to return mortar to battery.
.....	$12\frac{1}{4}$		3	.....	One hundred and twenty-six and a half pairs of springs in each cylinder.
.....	16		$3\frac{1}{2}$	Breechblock opened with slight difficulty. During motion of mortar into battery sounds heard distinctly, caused by rubbing of springs against walls of cylinders.	Barometer, 30.33; thermometer, 59°; humidity, 78. Firing conducted by Capt. F. Heath, Ordnance Department. Present: Maj. C. Comly, Ordnance Department; Capt. W. Crozier, Ordnance Department.
.....	$9\frac{1}{2}$	From right and rear 15°, 8 miles an hour; May 27, from right 5°, 4 miles an hour.	$2\frac{1}{2}$	.....	Mortar mounted on Easton & Anderson carriage. Two quarts of oil added to cylinders, filling them. Before this firing, springs of both cylinders turned down .02 of an inch to a uniform diameter of 8.7 inches.
.....	$16\frac{3}{4}$		$8\frac{1}{2}$	.....	Obturating friction primers.
.....	19		$8\frac{1}{2}$	Upper gear wheel on elevating shaft was struck by trunnion carrier and broken; broken part contains 11 teeth.	Mortar when being jacked to firing position bears against lower edge of left guide.
.....	$21\frac{1}{4}$		$9\frac{1}{4}$	Mortar jacked up to firing position; fell back $2\frac{1}{4}$ inches.	
M, 29, 300	$20\frac{3}{4}$		$14\frac{1}{4}$	Mortar one-half inch out of battery when fired.	Fired to sea.
M, 27, 660	$20\frac{3}{4}$		$13\frac{1}{4}$	After elevating and releasing jack, mortar fell back $1\frac{1}{4}$ inches and fired from that position.	Before firing, May 27, springs of both cylinders compressed 3 inches. Obturating plugs 1, 2, 3, 6, and 7 closed; $4\frac{1}{2}$ closed; $5\frac{1}{4}$ closed.
M, 28, 143	$20\frac{5}{8}$		$13\frac{1}{4}$	After elevating and releasing jack, mortar fell back $1\frac{1}{4}$ inches and fired from that position.	Copper cylinders of 24,000 pounds initial compression and tables of 1890.
.....	$19\frac{3}{4}$		$12\frac{1}{4}$	After elevating and releasing jack, mortar fell back $1\frac{1}{4}$ inches and fired from that position.	May 26: Barometer, 29.87; thermometer, 77°; humidity, 56.
.....	$20\frac{7}{8}$	May 26, from front and right 5°, 4 miles an hour; rear 15°, 8 miles an hour.	13	After elevating and releasing jack, mortar fell back $1\frac{1}{4}$ inches and fired from that position. Time of flight, 1 minute.	May 27: Barometer, 29.60; thermometer, 77°; humidity, 56.
.....	20		13	After elevating and releasing jack, mortar fell back $1\frac{1}{4}$ inches and fired from that position.	

Record of firing with 12-inch B. L. mortar (cast iron) No. 1 (steel-hooped),

[Object of firing, test of Easton

Date.	No. of fire on carriage.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.
			Kind.	Weight.	Kind.	Weight.		
P. M.				*Lbs. Oz.*		*Pounds.*	*Inches.*	° ′
June 1	94	345	R. H. B., lot 9; density, 1.830.	78 0 842 prisms brown; 7 prisms black.	Mortar shell, lot 329.	630 natural weight..	91.5	75 00
June 1	95	346		78 0 842 prisms brown; 7 prisms black.		631 natural weight..	91.5	75 00
June 1	96	347		78 0 842 prisms brown; 7 prisms black.		629 natural weight..	91.5	75 00
June 1	97	348		78 0 842 prisms brown; 7 prisms black.		631 natural weight..	91.5	55 00
June 1	98	349		78 0 842 prisms brown; 7 prisms black.		627 natural weight..	91.5	50 00
A. M.								
June 2	99	350		78 0 842 prisms brown; 7 prisms black.		631 natural weight..	91.5	47 00
June 2	100	351		78 0 844 prisms brown; 7 prisms black.		630 natural weight..	91.5	45 00
June 2	101	352		78 0 842 prisms brown; 7 prisms black.		629 natural weight..	91.5	45 00
June 2	102	353		78 0 842 prisms brown; 7 prisms black.		628 natural weight..	91.5	48 00
June 2	103	354		78 0 843 prisms brown; 7 prisms black.		627 natural weight..	91.5	48 00
P. M.								
June 14	104	355	Sphero-hexagonal O. X. C.	40 0	Motor shell, lot 335.	630 natural weight..	91.5	60 00
A. M.								
June 15	105	356		60 0		629 natural weight..	91.5	60 00
June 15	106	357	R. H. B., lot 9.	70 0 755 prisms brown; 7 prisms black.		629 natural weight..	91.5	60 00
June 17	107	358	Sphero-hexagonal O. X. C.	40 0		629 natural weight..	91.5	60 00

South Boston Iron Works, at Sandy Hook, N. J., June 1 to 17, 1892.

& Anderson carriage, repaired.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Inches.*		*Inches.*		
.....	19½	June 1, from front and right, 4 miles an hour.	14½	Mortar 1¾ inches out of battery when fired. After firing and depressing mortar it fell back 2¾ inches. It then had to be raised ¾ inch before shot would enter for next round.	
.....	19⅛		14½	After loading and giving elevation, mortar fell back 2⅞ inches and fired from that position.	Mortar mounted on Easton & Anderson carriage.
.....	19		14½	Chase piece on front transom removed mortar 2⅞ inches out of battery when fired.	Obturating friction primers.
.....	18		13½	Mortar 2⅞ inches out of battery when fired.	Cylinders filled with oil.
.....	17¼		12¾	After loading and giving elevation, mortar fell back 3⅜ inches and fired from that position.	Chamber sponged out after each round.
.....	19		15½	Mortar 3⅛ inches out of battery when fired; wooden ramp driven back 5½ inches.	Difficulty each time in closing breechblock, a rope being used. Fired to sea. June 1: Barometer, 30.38; thermometer, 86°; humidity, 54.
.....	19		15	Mortar 3⅛ inches out of battery when fired; wooden ramp driven back 9 inches. Considerable leakage of oil at large screw plug at top of left cylinder.	One quart of oil added to cylinders, filling them.
.....	18¾		14½	Mortar 3⅛ inches out of battery when fired; wooden ramp pulled out 1 inch before firing, and driven back by shock 1 inch. Carriage driven to the rear so that it rested on the outside flanges of rollers and the front flanges of rollers rested on lower path. Run back in place by traversing a little. Upper and lower edges of roller path chipped slightly by the edges of the rollers.	Before this firing, threads of breechblocks smoothed down with file. Chamber sponged out after each round. June 2: Barometer 30.24; thermometer, 86°; humidity, 51.
.....	19		14½	Mortar 3⅛ inches out of battery when fired.	
.....	19	June 1, from front and right, 4 miles an hour; June 15, from front, 10 miles an hour; June 17, from front and right, 6 miles an hour.	15	Mortar 4 inches out of battery when fired.	
.....	.....		.....	Mortar 5¾ inches out of battery when fired. Recoil and counter recoil not taken.	
.....	$12\frac{5}{16}$		11	Springs of cylinders compressed 5 inches by screwing down plugs.	Before firing, June 14, 7 pairs of springs added to each cylinder and obturating plugs 1, 3, 4, 6, and 7 closed; 2¾ closed; 5⅞ closed.
.....	$13\frac{5}{8}$		12¾	Mortar $1\frac{5}{16}$ inches out of battery when fired. Brass union of lower equalizing pipe broken, allowing oil to escape.	Total number of pairs of springs in each cylinder, 133½. Fired to sea.
.....	10½	June 14, from right, 4 miles an hour; June 15, from front, 10 miles an hour; June 17, from front and right, 6 miles an hour.	10½	A new union to replace the one broken in previous round fitted. Obturating plugs 1, 4, 5, 6, and 7 closed; 2¾ closed; 3⅞ closed. Mortar $2\frac{1}{16}$ inches out of battery when fired.	Chamber sponged out after each round.

Record of firing with 12-inch B. L. mortar (cast iron) No. 1 (steel-hooped),

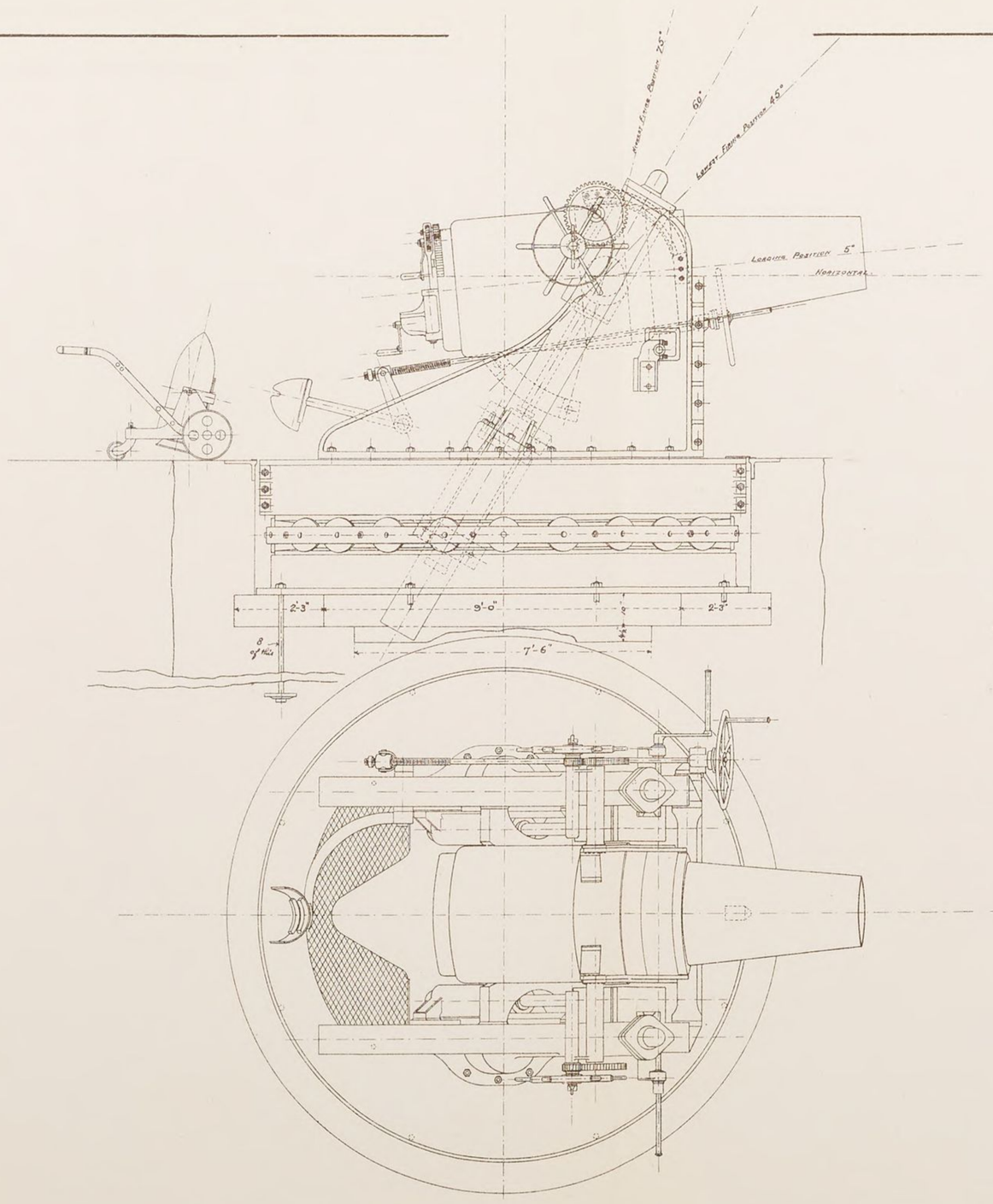
[Object of firing, test of Easton

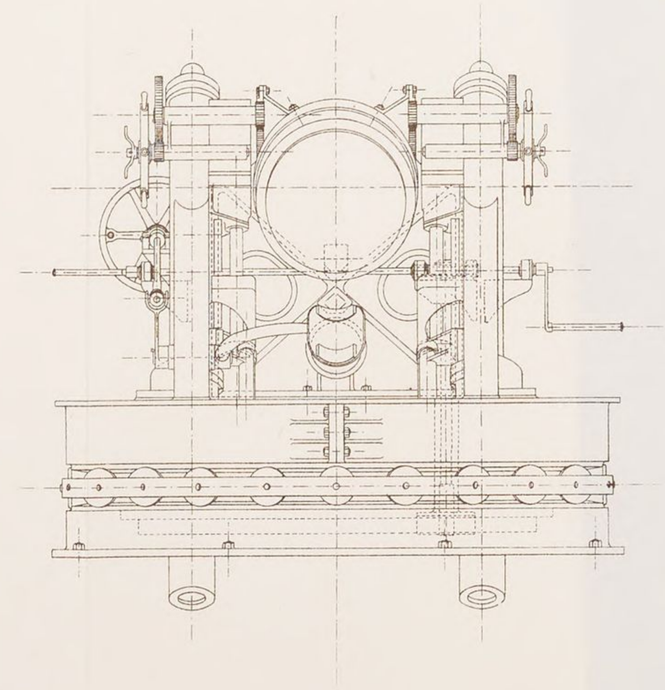
Date.	No. of fire on carriage.	No. of fire.	Powder.		Projectile.		Travel of shot in bore.	Elevation.	
			Kind.	Weight.	Kind.	Weight.			
				Lbs. Oz.		*Pounds.*	*Inches.*	°	′
A. M. June 17	108	359	R.H.B., lot 9.	70 0 755 prisms brown; 7 prisms black.	Mortar shell, lot 335.	632 natural weight..	91.5	60	00
P. M. June 21	109	360	O. X. C.	40 0		628 natural weight..	.....	60	00
June 21	110	361	R. H. B., lot 9.	70 0 755 prisms brown; 7 prisms black.		628 natural weight..	.....	60	00
June 21	111	362		78 0 842 prisms brown; 7 prisms black.		629 natural weight..	91.7	60	00
A. M. June 23	112	363	R. H. B.,	70 0 755 prisms brown; 7 prisms black.		626 natural weight..	91.6	60	00
June 23	113	364	Du Pont's brown prismatic R. H. B., lot 9; density, 1.830.	78 0 841 prisms brown; 7 prisms black.		629 natural weight..	91.7	60	00
July 2	114	365		70 0 755 prisms brown; 7 prisms black.		631 natural weight..	91.7	60	00
July 2	115	366		78 0 843 prisms brown; 7 prisms black.		629 natural weight..	91.7	60	00
July 2	116	367		78 0 843 prisms brown; 7 prisms black.		628 natural weight..	91.7	60	00
July 2	117	368		78 0 842 prisms brown; 7 prisms black.		629 natural weight..	91.65	60	00
July 5	118	369		70 0 755 prisms brown; 7 prisms black.		630 natural weight..	91.5	60	00
July 5	119	370	Sphero-hexagonal O. X. C.	40 0		630 natural weight..	91.5	60	00
July 5	120	371		78 0 842 prisms brown; 7 prisms black.		630 natural weight..	91.5	60	00
July 6	121	372		78 0 842 prisms brown; 7 prisms black.		626 natural weight..	91.7	65	00
July 6	122	373		78 0 842 prisms brown; 7 prisms black.		630 natural weight..	91.7	70	00
July 6	123	374		78 0 843 prisms brown; 7 prisms black.		633 natural weight..	91.7	73	00
July 6	124	375		78 0 843 prisms brown; 7 prisms black.		630 natural weight..	91.7	75	00
P. M. July 8	125	376	Du Pont's brown prismatic R. H. B., lot 9; density, 1.830.	78 0 843 prisms brown; 7 prisms black.		626 natural weight..	91.5	75	00
July 8	126	377		78 0 843 prisms brown; 7 prisms black.		626 natural weight..	91.5	55	00
July 8	127	378		78 0 842 prisms brown; 7 prisms black.		629 natural weight..	91.7	50	00
July 8	128	379		78 0 842 prisms brown; 7 prisms black.		628 natural weight..	91.7	48	00

South Boston Iron Works, at Sandy Hook, N. J., from June 17 to July 8, 1892.

& Anderson carriage, repaired.]

Pressure per square inch of bore.	Recoil.	Wind, strength and direction.	Counter recoil.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Pounds.	*Inches.*	June 17, from front and right, 6 miles an hour; June 21, from right and rear, 6 miles an hour.	*Inches.*		
.....	$12\frac{5}{8}$		$12\frac{1}{2}$	Mortar $2\frac{1}{16}$ inches out of battery when fired. Coupling of equalizing pipe broken, allowing oil to escape.	Mortar mounted on Easton & Anderson carriage.
.....	$10\frac{3}{4}$		$10\frac{3}{4}$	Mortar $2\frac{1}{8}$ inches out of battery when fired. A new lead gasket fitted to large top plug in left cylinder. Three brass couplings of connecting pipe replaced by wrought-iron ones.	Before firing, June 14, 7 pairs of springs added to each cylinder and obturating plugs 1, 3, 4, 6, and 7 closed; $2\frac{3}{4}$ closed; $5\frac{1}{4}$ closed.
.....	$12\frac{1}{2}$		$12\frac{1}{4}$	Mortar $2\frac{1}{8}$ inches out of battery when fired.	Total number of pairs of springs in each cylinder, $133\frac{1}{2}$.
.....	$14\frac{3}{8}$		14	Mortar $2\frac{1}{4}$ inches out of battery when fired. L on right side of lower connecting pipe broken.	Fired to sea. Chamber sponged out after each round.
.....	$12\frac{1}{4}$	From front, 2 miles an hour; from front, 2 miles an hour, July 5.	$12\frac{1}{4}$	Mortar $2\frac{5}{8}$ inches out of battery when fired; L on right side of lower connecting pipe; leaking slightly; tightened up.	
.....	$13\frac{7}{8}$		$11\frac{1}{4}$	Mortar $2\frac{5}{8}$ inches out of battery when fired.	Before this firing a new L fitted on right side of lower connecting pipe.
.....	$12\frac{1}{4}$		$12\frac{1}{4}$	.....	Cylinders filled with oil. Chamber sponged out after each round.
.....	13		$12\frac{3}{4}$	Mortar 1 inch out of battery when fired.	Fired to sea. Obturating friction primers.
.....	13		$12\frac{3}{4}$	Mortar $1\frac{1}{4}$ inches out of battery when fired.	Seven pairs of springs added to each cylinder after round 364, making a total of $140\frac{1}{2}$ pairs.
.....	$13\frac{1}{4}$		$12\frac{1}{2}$	Mortar $1\frac{1}{2}$ inches out of battery when fired.	Tray latch failed to hold console when block was being forced home in rounds 369 and 370.
.....	$12\frac{1}{4}$		$12\frac{1}{4}$	Springs of cylinders compressed 3 inches before this round.	
.....	$10\frac{3}{8}$		$10\frac{1}{4}$	.....	Barometer, 30.35; thermometer, 69°; humidity, 72.
.....	$12\frac{1}{2}$	From front and front 45°, 9 miles an hour, July 6, 1892; From front, 4 miles an hour, July 8, 1892.	$12\frac{1}{2}$	Mortar $\frac{1}{8}$ inch out of battery when fired.	
.....	$12\frac{1}{2}$		$12\frac{1}{2}$	.....	Barometer, 30.55; thermometer, 74°; humidity, 58.
.....	$13\frac{1}{4}$		$13\frac{1}{4}$	Breechblock opened with slight difficulty.	Obturating friction primers.
.....	$12\frac{1}{2}$		$12\frac{1}{2}$	.....	Fired to sea.
.....	$12\frac{1}{2}$		$12\frac{1}{2}$	.....	Barometer, 30.40; thermometer, 80°; humidity, 44.
.....	$12\frac{1}{4}$		$12\frac{1}{4}$	.....	Firings conducted by the proof officer in the presence of the Ordnance Board. Present: Maj. C. Comly, Ordnance Department; Capt. F. Heath, Ordnance Department; Capt. W. Crozier, Ordnance Department.
.....	$12\frac{1}{2}$	From right and front 45°, 9 miles an hour, July 6, 1892; From right, 5 miles an hour, July 8, 1892.	$12\frac{1}{2}$	Slight leakage of oil at emptying plug of right cylinder.	
.....	$12\frac{1}{2}$		$12\frac{1}{2}$	Slight leakage of oil at emptying plug of right cylinder.	
.....	$12\frac{1}{2}$		$12\frac{1}{2}$	Breechblock sticks in opening after one turn. Leak at emptying plug of right cylinder.	





A.720.

UNITED STATES ARTILLERY.

12" MORTAR MOUNTING.

RAZKAZOFF'S PATENT SYSTEM.

SCALE :— 3/4" INCH TO ONE FOOT.

JUNE 1889.

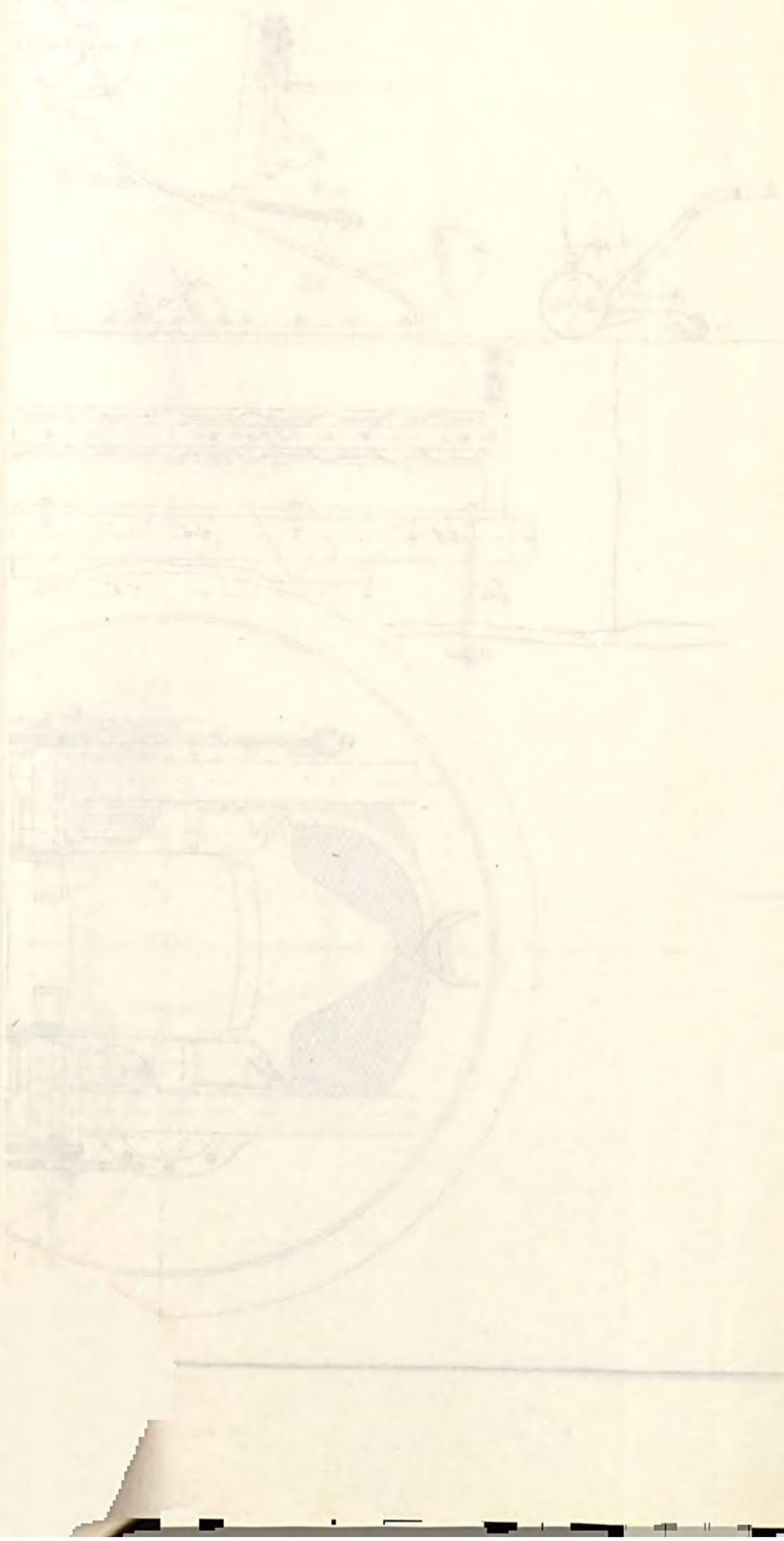
(This tracing taken from print. Oct. 3rd 1892.)

FOR
THE ORDNANCE BOARD.

Chas. Crowley

MAJOR ORDNANCE DEPT. U.S.A.
PRESIDENT.

Appendix 43, 1892.



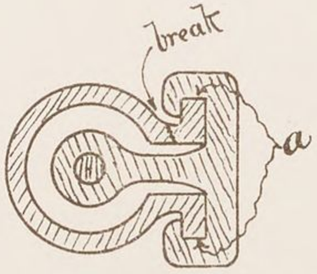


Fig. 1.

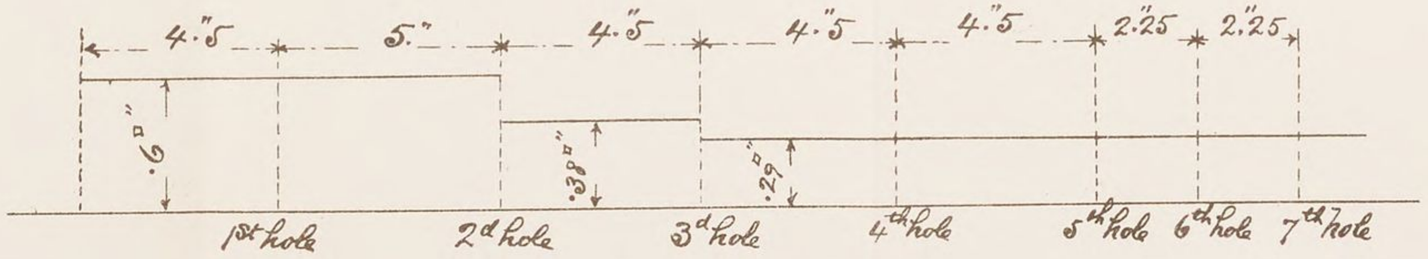


Fig. 3

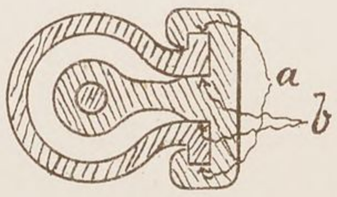


Fig. 2

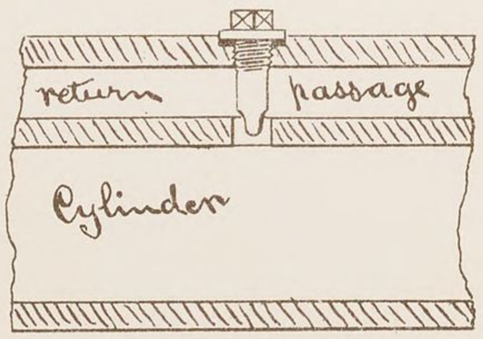


Fig. 4

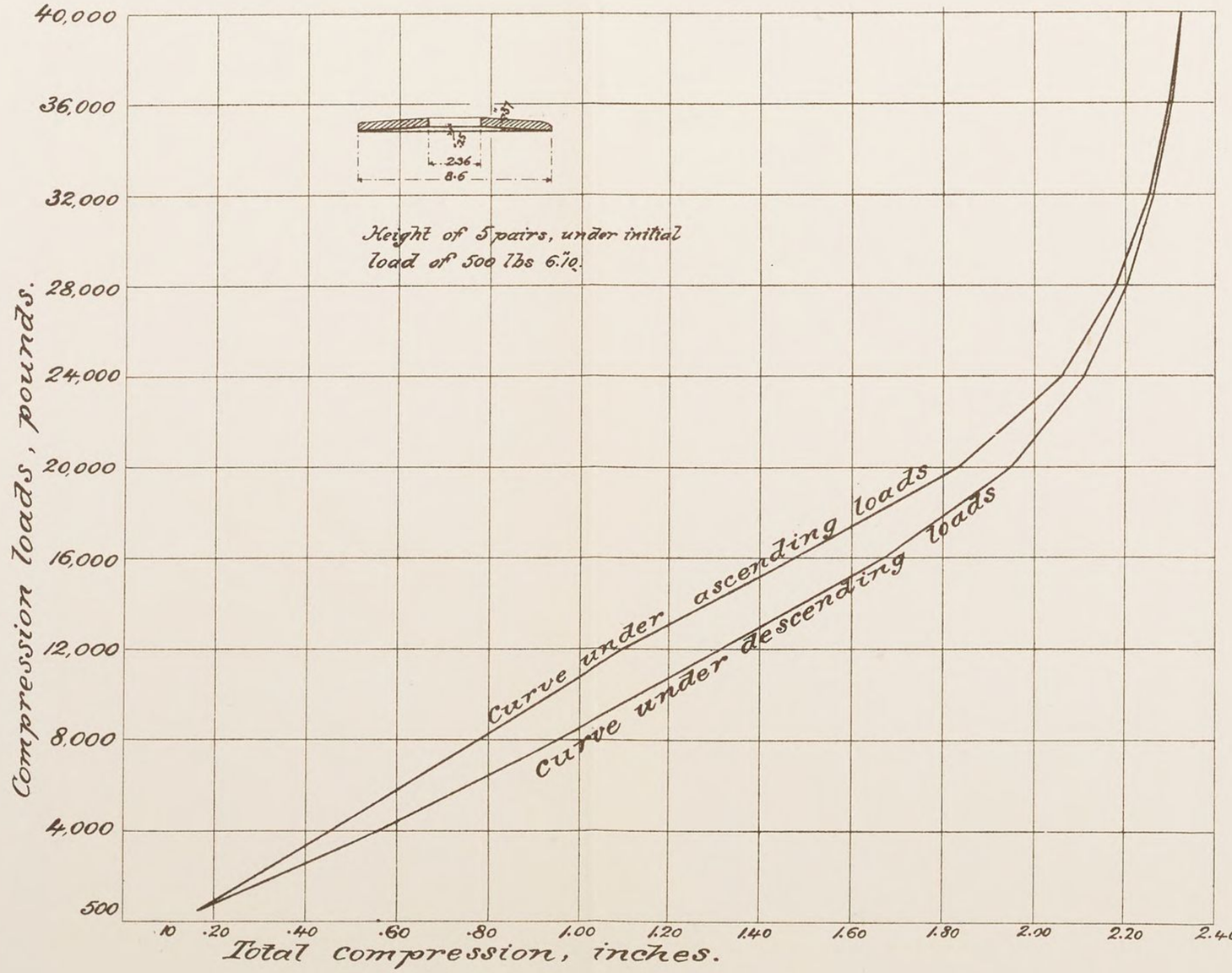
FOR
THE ORDNANCE BOARD
Captain Leonard
MAJOR ORDNANCE DEPT.
U.S.A.

PRESIDENT

Appendix 43, 1892.

Belleville Springs.

Diagram showing curve under compressive stress of five pairs of springs from Easton and Anderson Mortar carriage.



FOR THE ORDNANCE BOARD

Captain Comly

MAJOR ORDNANCE DEPT. U.S.A.
PRESIDENT.

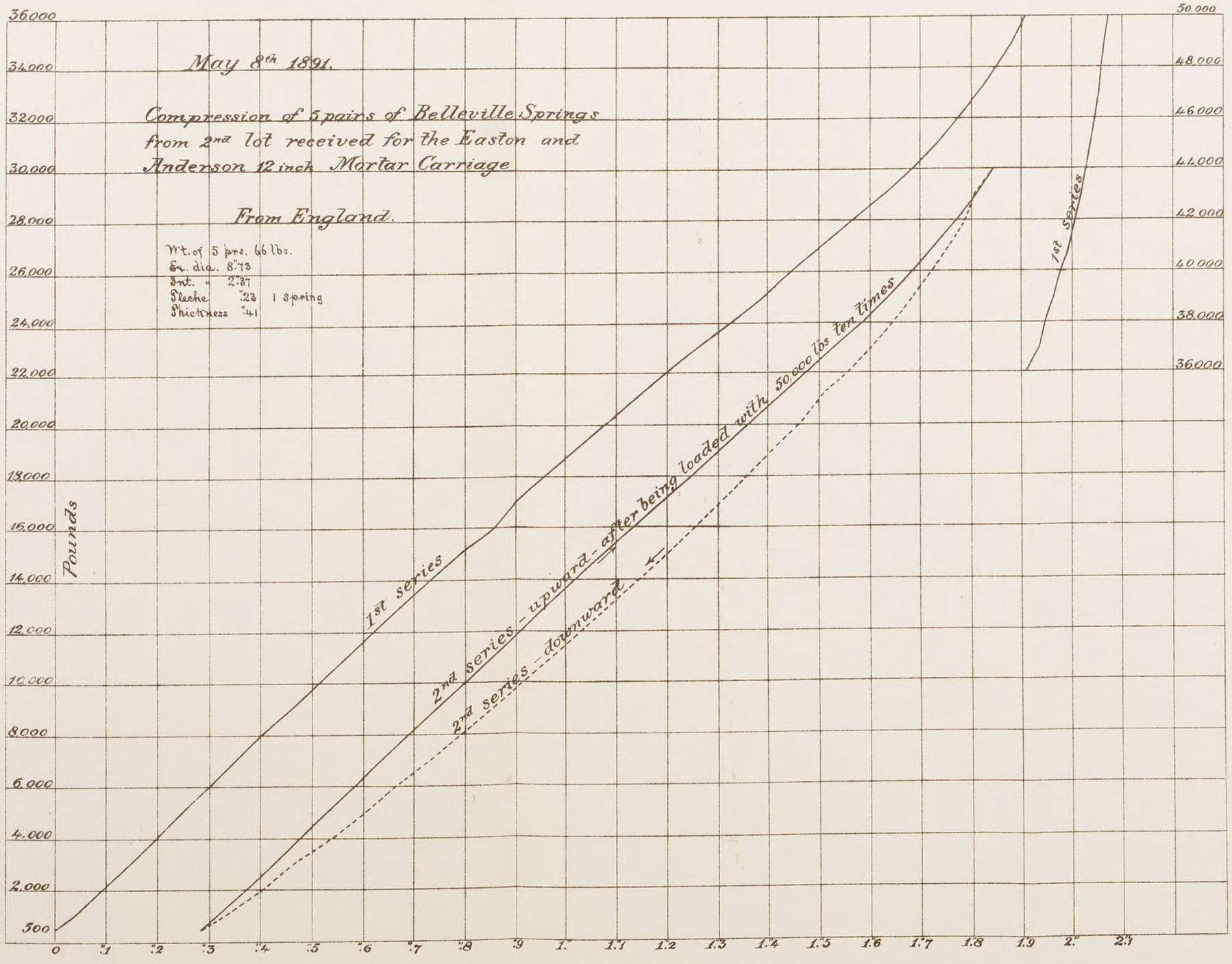
Appendix 43, 1892.

May 8th 1891.

Compression of 5 pairs of Belleville Springs from 2nd lot received for the Easton and Anderson 12 inch Mortar Carriage

From England.

Wt. of 5 prs. 66 lbs.
Ext. dia. 8.73
Int. " 2.37
Pleche .23 1 spring
Thickness .41



FOR THE ORDNANCE BOARD
captain
MAJOR ORDNANCE DEPT. U.S. A
PRESIDENT.

APPENDIX 44.

FRANKFORD ARSENAL COMBINATION FUSE, MODEL 1891; EFFECTS OF WEATHER AND TEMPERATURE; GRADUATION OF FUSE FOR SERVICE.

(1 plate.)

FRANKFORD ARSENAL,
Philadelphia, Pa., July 28, 1892.

SIR: I have the honor to make the following report in connection with Experimental Programme No. 17, dated June 9, 1892, which had for its object the determination of the effect of varying conditions of weather and temperatures on the Frankford Arsenal combination fuse, as directed by the Chief of Ordnance, U. S. Army, January 26, 1892:

Twenty fuses were taken for the trial, and were disposed as follows: Five exposed to heat of 100° and upwards during the day; five packed in a box as for store; five exposed to vapor of water; five exposed to the weather, but protected by a board from the direct action of the sun or rain. One from each lot was sent to the proof house at the expiration of every ten days, and timed with the Schultz chronoscope.

Those exposed to heat were placed in the wall between the dry and washroom of the case shop, and the temperatures ranged during the day from 93°, at 8 a. m., to a maximum of from 101° to 116° during the day. At night the temperature fell when the steam was shut off.

The fuses were all cut to 8 inches, as a comparison with the burning at flight was thus afforded, those fired at Sandy Hook April 4, 1892, having been cut for 8 inches.*

The following are the results:

Frankford Arsenal combination fuse. Cut to 8 inches.

[Time taken with Schultz chronoscope.]

Date.	No.	In store.	Exposed.			Thermometer (F.).		Barometer.
			Weather.	Vapor.	Heat.	Dry.	Wet.	
1892.						°	°	
June 14	1	7.536	7.772	7.781	7.700	90	77	29.90
24	2	7.558	7.722	7.715	7.795	84	70	29.96
July 5	3	7.693	7.619	7.560	7.729	74	67	30.28
14	4	7.722	7.712	7.572	7.706	82	76	29.95
25	5	7.696	7.696	7.724	7.637	84	74	30.00
Total		38.205	38.521	38.452	38.567			
Mean		7.641	7.704	7.690	7.713			
Greatest variation		0.186	.153	.181	.158			
Greatest variation in all 7.536 to 7.795 = .259.								

NOTE.—The British Government allows an extreme variation of 0.3 second in Armstrong time fuses.

* Nominal time being understood. The length of fuse train cut in these experiments was 5.63 inches.

The plungers were fired by a drop weight. All fired promptly except that exposed to vapor, fourth series, which required four blows, and that exposed to vapor, fifth series, which would not explode. This latter was damp. As the composition is protected by a piece of foil fastened with shellac, it is probable that the shellacking was not properly done. The ring of compressed powder was apparently not injured, as with a new plunger the fuse fired properly. With the outside tinfoil cover all danger of a recurrence of this will be avoided. The protection given to the fuse from moisture is ample.

A table is appended giving the circumstances of temperatures and weather during the continuance of the trial.

Respectfully,

FRANK BAKER,
Captain of Ordnance.

The COMMANDING OFFICER FRANKFORD ARSENAL.

Respectfully forwarded to the Chief of Ordnance, U. S. Army.

J. PITMAN,
(2028–'92.) *Captain of Ordnance, Commanding.*

Record of mean daily temperatures (F.) and weather during the foregoing trial:

[3 records made daily at 8 a. m., 1 p. m., and 4 p. m.]

Date.		Outside.	Heat.	Vapor.	Store.
	1892.				
June	4	68	102	77	77
	6	82	105	81.6	81.6
	7	79.6	104.6	81	81
	8	73.6	104.3	77.6	77.6
	9	81.3	108	80.6	81
	10	72.6	106	78	78
	11	77	105.3	79	79
	13	89	111.3	85.6	86
	14	88.6	112.6	86.3	86
	15	84.6	111.3	85	85
	16	83	110	82.6	82
	17	88	113.3	86	85.6
	18	79.3	107.3	76.6	80.3
	20	88.6	110	86.3	86
	21	86	113.3	87	86.3
	22	89	115.3	83	88.3
	23	88	109.3	86.3	86.3
	24	83.6	113	84.3	84.3
	25	82.3	112.6	83	83
	27	81.3	101.6	81.3	81.3
	28	79.6	110	80.3	80.3
	29	83	108.6	82	82
	30	84.6	116.3	84.3	84.3
			No steam.		
July	1	69.3	97.3	74	74
	2	76.6	83.3	74	74
	5	76.6	76.6	75.6	75.3
	6	80	85.3	79	79
			Steam.		
	7	77.6	96.6	78.6	78.6
	8	80.6	98.3	80.6	80.6
	9	81.6	104.3	81.3	81.3
	11	83.3	101.3	83.3	83.3
	12	86	104.6	85.3	85
	13	88.3	106.3	87.3	86.6
	14	83.3	102	85.6	85.6
	15	88.6	108.3	87.6	87.6
	16	81	109.3	84.6	84.6
	18	80.3	101.3	81.3	81.3
	19	82	106.3	81.6	81.6
	20	81.3	110	84	84
	21	80.3	110.6	83	83
	22	86	111.3	85	85
	23	87	113.3	86.3	86.3
	24	88	110	88	88

12 days clear, 19 days partly cloudy, 6 days cloudy, 10 days rain.

GRADUATION OF FRANKFORD ARSENAL COMBINATION FUSE, MODEL 1891.

ORDNANCE OFFICE, WAR DEPARTMENT,
July 29, 1892.

SIR: Pursuant to your instructions, I submit herewith an account of the methods adopted for determining the service graduation of the combination fuse with tubular time train, manufactured at the Frankford Arsenal and previously described in Appendix 20 of your annual report for 1891. The data herewith made use of are derived from reports of the commanding officers of Frankford Arsenal and the Sandy Hook proving ground.

The graduation of the fuse for service as directed by you is based upon the time of *burning in flight*. Each entire second is marked by a through hole in the cone cover, numbered from 1 to 15, inclusive, and each of these spaces further subdivided into six equal parts marked by holes nearly through the cover, making the least division of the scale correspond to one-sixth of a second.

With the 3.2-inch field gun one division of this scale will give approximately the following intervals in range, viz: 70 yards at 1,000, 55 yards at 2,000, 48 yards at 3,000, and 42 yards at 4,000 yards range.

By this method of graduation, the same fuse may be used with different guns, permitting interchange in the field which could not be done if a scale of yards, requiring a distinct graduation for each gun, were employed. This graduation is essentially a scale of divisions, differing from the arbitrary scales of inches, tenths, etc., sometimes used, in that the divisions of the scale and times of flight pertaining to the range tables of the guns are synonomous.

The fuse scale should therefore be entered in the range tables under the caption "divisions of the fuse scale," and in a column next to that containing the ranges. The range and division opposite to it in the table may then both be called by command, or if one is given the other will be indicated by the table. At the same time, under ordinary conditions of fire, the cut of the fuse will indicate the time of flight to point of burst and the corresponding range, whereby the fuse may serve as an auxiliary in determining unknown ranges.

The determination of this graduation has required a series of firings on the proving ground for the measurement of ranges and the corresponding times of flight. Before being sent to the proving ground the fuses were graduated at Frankford Arsenal in seconds with reference to the measured time of burning at rest.

This was done in order to derive the advantage which the principle of a fuse scale based on the time element affords with reference to the graduation of subsequent lots of fuses of similar manufacture without repetition of the firing tests. That is, the time of burning at rest may be determined by the appliances at Frankford Arsenal for each lot of fuses manufactured, and whilst lots made at different times may show variations in the rate of burning, yet each separate lot should have a uniform rate. Then, with this variable only, which should be small in amount to contend with if we determine the difference in percentages between the rates of burning at rest and in flight for one lot of these fuses, the same percentages may be applied in subsequent manufactures to convert the rest scale, determined at the place of manufacture, into the service scale, or that corresponding to the time of burning in flight.

It may be further observed that the 3.2-inch field gun used in the present tests has an intermediate initial velocity amongst the field and siege guns with which the fuse may be used, and the assumption is made that the percentage of difference in rates of burning at rest and in flight as determined by firing with this gun will not be materially changed in firing with the 3.6-inch or 5-inch rifles.

Record of observations at Frankford Arsenal for time of burning at rest.—The rest scale.

The object being to determine the consecutive lengths of train corresponding to each entire second of time of burning within the limits of the train, a number of fuses were burned with the time train cut to varying lengths and the time of burning for each cutting measured by means of the Schultz chronoscope. This record comprises more observations than may be deemed necessary for future lots of fuses. At first a number of observations were made on the tentative principle of seeking the length of train corresponding to a given number of seconds by trial. Taking one second, for example, on trying a length of 0.6 of an inch, the time was found to be somewhat less than a second. The cut was then proportionately increased and the next trial made on a length of 0.62 of an inch. Finally, however, under experimental programme No. 9, as reported from Frankford Arsenal May 11, 1892, a consecutive and more systematic series of experiments were made at one-half inch intervals over the whole length of the train, the conditions being as follows:

Lengths of time train of 0.5, 1.0, 1.5, and 2.0 inches, etc., up to and including 11 inches to be burnt and the corresponding times determined by the chronoscope. Two observations to be taken for each of the above lengths of train.

The observations pertaining to this series are designated by an asterisk in the appendix entitled "Tabulation of records at Frankford Arsenal for time of burning at rest."

Wherever lengths of train in inches are mentioned it will be understood that the origin of lengths is taken at the end of the train proper or the entrance to the channel which connects with the explosive charge of powder in the fuse stock. The origin of time measurements coincides with the moment of burst of fuse. The time record comprises therefore—

Not only the time of burning of a given length of train, but also the time which elapses between the moment the flame reaches the zero of train and the moment the flame passes through the bottom of the fuse. This constant was determined by the following five observations on the chronoscope:

	Second.
	0.0305
	.0297
	.0390
	.0304
	.0274
Mean.....	.0314

From which a value of 0.03 of a second has been taken to be considered a constant and applicable to the burning of the fuse, whether at rest or in flight.

Again, the time of burning at rest is measured from the cut in the time train and does not include the time required for ignition of fuse;

that is, the time elapsing between the moment the plunger begins to fall and the moment the train begins to burn. This interval, determined by the chronoscope, is found to have a constant value equal to 0.006 of a second. But inasmuch as this interval is sensibly equal to that required for the projectile to traverse the bore of gun and the origin of times in flight is taken from the muzzle of the gun, this constant of time is eliminated.

By the method of reducing each time observation at Frankford to the nearest entire second as noted in the appendix the observations made at different times and with varying lengths of train are reduced to a common basis, and the greatest number of available observations is utilized to obtain the mean length of train for each entire second of burning at rest. These mean values with slight adjustment are collected in the following table to constitute the so-called rest scale of the lot of 2,000 fuses in question.

TABLE I.—*Graduation of fuse—Rest scale.*

Time of burning.	Length of train.		Time of burning.	Length of train.		Time of burning.	Length of train.	
	Total.	Δ		Total.	Δ		Total.	Δ
Seconds.	*Inches.*	*Inch.*	*Seconds.*	*Inches.*	*Inch.*	*Seconds.*	*Inches.*	*Inch.*
1	0.64	.....	6	4.19	0.75	11	8.08	0.76
2	1.32	0.68	7	4.98	0.79	12	8.84	0.76
3	2.01	0.69	8	5.77	0.79	13	9.58	0.74
4	2.72	0.71	9	6.56	0.79	14	10.32	0.74
5	3.44	0.72	10	7.32	0.76	15	11.06	0.74

Record of firing tests at the proving ground for time of burning in flight.

The record of the firing tests which are hereto appended comprise in all the firing of 42 fuses fitted to 3.2 inch common shell with band 0.625 of an inch from base, charged and ballasted to the standard weight of 13.5 pounds. There was no failure of the fuse to act, although from other causes the observations on three were lost.

The primary object of these firings was to determine the time of burning in flight as compared with that at rest for identical *lengths* of train, and thus ascertain the corrections to be applied to the "rest" scale in order to produce the service scale.

In the expectation that constant difference or percentage would be found to exist between the times of burning at rest and in flight which would be discovered by comparisons made at any point in the trajectory, the first firings were made at two points for lengths of train cut to 1.305 and 3.428 inches, respectively, corresponding to two and five seconds rest time approximately. Subsequently, as it was found necessary to extend the points of comparison, duplicate sets of firings were made with a cutting of 5.63 inches, corresponding to 8 seconds rest time approximately; and finally the series were completed by firings made with cuttings of 2.01, 4.19, 6.56, and 8.84 inches, respectively, corresponding to 3, 6, 9, and 12 seconds of the rest scale given in Table I, which had meantime been established.

Omitting the first set of firings at 8 seconds (April 4, 1892), by reason of their apparent inconsistency, the remaining sets enable the desired comparisons to be drawn at seven points of the trajectory, corresponding to 2, 3, 5, 6, 8, 9 and 12 seconds of the established rest scale, and from these the service scale hereafter given is deduced.

Separate firings were made at the proving ground in connection with

each test of the fuse to determine the initial velocity for the gun and powder used, for although a uniform charge of 3.75 was used it was taken from different lots of Du Pont's I. K. H. powder, which gave different initial velocities. The gun was given a sufficient elevation to cause the fuse to burst before striking the ground, and the range to point of burst for each shot was closely determined by poles set up at intervals of 200 feet by observers placed opposite. Check observations for time were made by observers with stop-watches, of which the least reading, except by estimation, was one-fourth of a second. From what follows it will appear that the observed times were generally about 0.2 of a second greater than the computed times derived from the measured ranges. The firings were, as far as possible, made under uniform conditions as to wind, and generally with the wind directly across the range, except at 6 and 12 seconds, where the effect of the head winds will be considered.

To facilitate reference thereto, the following observed data from the firing records is presented, in remarking that the entries of 2, 5, and 8 under "fuse cut at seconds" and relating to the rest scale are nominal only; they strictly represent 1.98, 4.98, and 7.82 seconds, respectively, of the rest scale and will subsequently be so considered.

TABLE II.—*Observed firing data.*

FEBRUARY 24, 1892.

Gun.	No. of fire.	Fuse cut at—	Measured range at burst.	Time of flight. Watch.	Watch.	Watch.	Remarks.
		Secs.	*Yards.*	*Secs.*	*Secs.*	*Secs.*	
3.2-inch, No. 18....	1595	2	904	2.25	.....	2.25	
	1596	2	895	2.00	.....	2.00	
	1597	2	880	2.00	2.00	2.00	
	1598	2	854	2.00	2.00	2.00	
	1599	2	880	2.00	2.00	2.25	
Mean.....	.....	.....	883	2.05	2.00	2.10	Barometer, 30.24; thermometer, 38.0; wind from left 90°, 14 miles per hour.
	1589	5	1,960	.....	.....	5.25	
	1590	5	*2,103	*5.50	.....	*5.50	
	1591	5	1,965	5.00	.....	5.00	
	1592	5	1,970	5.25	.....	5.25	
	1593	5	1,970	5.00	.....	5.00	
Mean.....	.....	.....	1,966	5.083	.....	5.125	

MAY 2, 1892.

3.2-inch, No. 18....	1697	8	3,036	8.25	.....	8.25	
	1698	8	3,035	8.50	.....	8.50	
	1699	8	3,053	8.50	.....	8.50	Barometer, 29.96; thermometer, 78.0; wind from right 90°, 8 to 14 miles per hour.
	1700	8	3,038	8.25	.....	8.25	
	1701	8	3,016	8.00	.....	8.00	
	1702	8	3,043	8.375	.....	8.50	
Mean.....	.....	.....	3,037	8.312	.....	8.33	

JUNE 30, 1892.

3.2-inch, No. 32....	124	3	1,397	3.125	.....	3.50	Barometer, 30.11; thermometer, 80.0; wind, 10 to 11 a. m., right, 90°, 14 miles; 11 to 11:30 a. m., front, 0–8 miles per hour.
	125	3	1,422	3.25	.....	3.25	
	126	3	1,425	3.50	.....	3.375	
	127	3	1,358	3.00	.....	3.00	
Mean.....	.....	.....	1,401	3.22	.....	3.28	

TABLE II.—*Observed firing data*—Continued.

JULY 5, 1892.

3 2-inch, No. 32....	130	6	2,403	6.375	.....	6.375	Barometer, 30.43; thermometer, 78.0; wind, from front, 1 to 3 p. m., 12 miles per hour; 3 to 4 p. m., 11 miles per hour.
	131	6	*2,556	*7.00	.....	*7.00	
	132	6	2,417	6.50	.....	6.375	
	133	6	2,440	6.125	.....	6.25	
	134	6	2,468	6.75	.....	6.50	
Mean.....	.....	.....	2,433	6.437	.....	6.375	

JULY 6, 1892.

3.2-inch, No. 32....	136	9	3,468	9.75	.....	10.00	Barometer, 30.55; thermometer, 74.0; wind from right, 10 to 11 a. m., 2 miles per hour; 11 to 12 a. m., 4 miles per hour.
	137	9	3,465	9.75	.....	9.625	
	139	9	3,480	10.00	.....	10.00	
	140	9	3,433	9.75	.....	10.00	
Mean.....	.....	.....	3,461	9.81	.....	9.91	
	142	12	4,189	13.00	.....	13.00	Barometer, 30.63; thermometer, 76.0; wind, from right and front, 45°; 3 to 4 p. m., 9 miles per hour; 4 to 4:30 p. m., 4 miles per hour.
	143	12	4,237	13.25	.....	13.25	
	144	12	4,228	13.25	.....	.....	
	145	12	4,239	13.00	.....	13.25	
	146	12	4,230	13.25	.....	13.125	
Mean.....	.....	.....	4,225	13.15	.....	13.156	

* Omitted from average.

By reason of the nonomission of the fifth shot at 8 seconds an allowance for wind at 6 seconds and for wind and elevation at 12 seconds, the computed results from the firing data given in the following table differ slightly from those stated in the appended firing records. The computations for initial and terminal velocity and time of flight from the observed or corrected mean range include corrections for the readings of barometer and thermometer, and are based upon a value for the coefficient of reduction, *c*, equal to 0.9.

TABLE III.—*Computed time of flight, etc.*

Fuse cut at—	Mean range.	Initial velocity.	Terminal velocity.	Time of flight.
Secs.	*Yards.*	*Ft. secs.*	*Ft. secs.*	*Secs.*
2	883	1,635	1,245	1.86
3	1,401	1,661	1,132	3.10
5	1,966	1,635	974	4.87
6	*2,454	1,661	938	6.21
8	3,037	1,659	871	8.12
9	3,461	1,661	817	9.70
12	*4,255	1,661	744	†12.88

*Corrected for wind. † Corrected for elevation of 9° 33 seconds.

Collecting the data for length of fuse train cut and the corresponding times of burning at rest and in flight (computed and observed), for comparison in the several firings, we have the following mean values:

TABLE IV.—*Comparison of time of burning, at rest and in flight.*

Length of train.	Time of burning.			
	At rest.	In flight.		
		Computed.	Observed.	Difference.
Inches.	*Seconds.*	*Seconds.*	*Seconds.*	*Seconds.*
1.305	1.98	1.86	2.05	0.19
2.010	3.	3.10	3.25	0.15
3.428	4.98	4.87	5.10	0.23
4.190	6.	6.21	6.41	0.20
5.630	7.82	8.12	8.32	0.20
6.560	9.	9.70	9.86	0.16
8.840	12.	12.88	13.15	0.27

From the fair degree of uniformity observed in the differences between the computed and observed times in flight—the latter being the longer by an average of about 0.2 of a second for all ranges—the accuracy, or at least the general consistency, of the computed times may be considered fairly well established, and their values as given in the table will be taken for further reference.

It is found, as will be presently shown, that whilst the firings at approximately 2, 5, and 8 seconds (rest time) give a consistent series when taken together, and likewise those at 3, 6, and 9 seconds, yet the two series are not consistent with each other and must be considered separately. From the several 3-second intervals in the two series we find the average length of train burned per second in flight, between 2 and 8 seconds, is 0.69 of an inch, nearly. This enables us to correct the values of Table IV as needed to embody only entire seconds of the rest scale for further reference. Thus the lengths of cut for 2, 5, and 8 seconds will be increased 0.15, 0.12, and 0.14 of an inch, respectively, and the corresponding times of burning in flight become proportionally increased to 1.88, 4.89, and 8.32 seconds. These corrections are entered in the following table, where, for convenience, the deduced lengths of train for flight in the two series referred to are placed separately.

TABLE V.—*Deduced lengths of train for flight.*

Time of burning.			Length of train.		
				In flight.	
At rest.	In flight.	Difference.*	At rest.	First series.	Second series.
Seconds.	*Seconds.*	*Per cent.*	*Inches.*	*Inches.*	*Inches.*
2	1.88	+6.48	1.32	1.40	.....
3	3.10	—3.25	2.01	.....	1.94
5	4.89	+2.26	3.44	3.51	.....
6	6.21	—3.40	4.19	.....	4.04
8	8.32	—3.86	5.77	5.55	.....
9	9.70	—7.25	6.56	.....	6.09
12	12.88	—6.84	8.84	.....	8.24

* For example: $(2-0.03)-(1.88-0.03)\div 1.85=0.0648$.

The intervals (length of time) between 2 and 3, 5 and 6, and 8 and 9 seconds, instead of being about 0.69 of an inch as indicated by the two series taken separately, are found by combining the two series to be 0.54, 0.53, and 0.54 of an inch, respectively, and must evidently be increased. In view of the remarkable uniformity of these reduced differences taken at three separate points in the two series, and in the absence of any facts tending to show that the two series are not equally reliable, it is concluded that the lengths of train in the first series are as much too long as those in the second are too short, and that by averaging the two on this basis we will obtain an approximately true scale for burning in flight under varying conditions of service. Then extending each series separately by its own intervals, as found up to 9 seconds, and considering that the average of 0.68 of an inch for length of train per second in flight, deduced for the intervals between 7 and 9 seconds, should be extended to 15 seconds, we obtain the lengths of train to be taken for the service graduation in seconds. The several curves are plotted; Pl. I referred to entire seconds of time of burning on the horizontal axis, whilst the ordinates represent the corresponding lengths of train. The two principal curves relate to the burning at rest and in flight, the latter being intermediate (up to beyond 9 seconds) to the two auxiliary curves upon which it depends, plotted from the two series of firings.

The following table gives the lengths of train thus determined for the service graduation, and the corresponding lengths for burning at rest, together with the percentage of difference between them, which will serve to correct the rest scale as determined for newly manufactured lots of fuses of similar construction:

TABLE VI.—*Service graduation.*

Divisions of the fuse scale.	Length of train for service.		Length of train burning at rest.		Difference in lengths of train.
Seconds.	*Inches.*	△	*Inches.*	△	*Per cent.*
1	0.64	.....	0.64	.....	0.
2	1.32	68	1.32	68	0.
3	2.01	69	2.01	69	0.
4	2.71	70	2.72	71	0.37
5	3.41	70	3.44	72	0.87
6	4.10	69	4.19	75	2.14
7	4.79	69	4.98	79	3.80
8	5.47	68	5.77	79	5.20
9	6.15	68	6.56	79	6.25
10	6.83	68	7.32	76	6.70
11	7.51	68	8.08	76	7.05
12	8.19	68	8.84	76	7.35
13	8.87	68	9.58	74	7.40
14	9.55	68	10.32	74	7.45
15	10.23	68	11.06	74	7.50

It will be observed that the lengths of train are the same in the two cases up to 3 seconds, inclusive, and beyond that there is an increasing percentage of reduction in lengths to be applied to the lengths at rest to determine those for flight or service. The results show that the rate of burning at the longer ranges is materially slower in flight than at rest.

Reverting to the apparent inconsistency found to exist between the scales deduced from the computed times of flight in the series of 2, 5, 8, and 3, 6, 9 seconds, taken separately, it will be observed that a similar discrepancy exists with regard to the observed times of flight taken in the same series. To illustrate this and for possible future reference, the lengths of train developed separately for the two series of firings and for the two methods of time determination are given in the following table. Beyond 9 seconds all the scales are constructed by adding a common interval of 0.68 of an inch for each second.

TABLE VII.—*Various lengths of train determined from observation of fuse in flight.*

Time of burning.	Computed time.			Observed time.			Mean of all lengths.	
	First series.	Second series.	Difference.	First series.	Second series.	Difference.		
Seconds.	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*Inches.*	*Inch.*	*Inches.*	*d.**
1	.....	.....	.....	.....	.....	.....	0.60	—0.04
2	1.40	1.24	0a.16	1.27	1.15	0.12	1.27	5
3	2.10	1.94	0.16	1.97	1.84	0.13	1.96	5
4	2.80	2.64	0.16	2.66	2.53	0.13	2.66	5
5	3.51	3.35	0.16	3.36	3.22	0.13	3.35	6
6	4.19	4.04	0.15	4.04	3.91	0.13	4.04	6
7	4.87	4.72	0.15	4.73	4.59	0.14	4.73	6
8	5.55	5.40	0.15	5.41	5.28	0.13	5.41	6
9	6.23	6.08	0.15	6.09	5.97	0.12	6.09	6
10	.....	.....	.....	.....	.....	.....	6.77	6
11	.....	.....	.....	.....	.....	.....	7.45	6
12	.....	.....	.....	.....	.....	.....	8.13	6
13	.....	.....	.....	.....	.....	.....	8.81	6
14	.....	.....	.....	.....	.....	.....	9.49	6
15	.....	.....	.....	.....	.....	.....	10.17	—0.06

* *d* represents the difference between the general mean and the mean deduced from computed times only, *i. e.*, the service scale, Table VI.

By converting the differences given in inches into seconds, we have a constant difference of about 0.22 of a second in the absolute computed times in the two series and a similar difference of about 0.18 of a second in the absolute observed times. These differences indicate some constant source of discrepancy, which remains at present unexplained. The service scale now given, Table VI, represents nearly the mean from the computed times. The computed times only have been taken for this scale, to the exclusion of the observed times, since it is the computed times, as given in the tables of fire, to which reference will be made in the use of the fuse in service.

The scale indicated by the mean of all observations as given in Table VII agrees closely with that under the computed time in the second series, or the latest trials of the fuse, and possibly may be found in more extended use of the fuse to be more nearly correct than the scale which we have now adopted. In that event, as deduced from the present data, the service scale for any lot of similar fuses would be derived by first determining the lengths of train for time of burning at rest, and then reducing such length by the following *percentages* from 1 to 15 seconds consecutively, viz: 6.2, 3.8, 2.5, 2.2, 2.6, 3.6, 5.0, 6.2, 7.2, 7.5, 7.8, 8.0, 8.0, 8.0, 8.0. By converting into seconds the difference in lengths of train for this scale and that adopted as given in the last column, Table VII, it is seen that the adopted scale will give the greater times of burning by a nearly constant difference of 0.1 of a second for all ranges.

Respectfully,

ROGERS BIRNIE,
Captain, Ord. Dept., U. S. Army.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

APPENDIX.

TABULATION OF RECORDS AT FRANKFORD ARSENAL FOR TIME OF BURNING AT REST.

Columns 1 and 3 give the length of train cut and the corresponding time of burning as recorded, including in each case the constant time (0.03 of a second) of burning between the zero of the train and the burst of the fuse.

Column 5 gives the proportionate length of train for entire seconds in time of burning at rest. In deducing the values given in this column the recorded times of burning (column 3) and the entire seconds (column 4) have each been diminished by the constant 0.03 of a second to eliminate that part of the time which does not pertain to the train. Each observation is then reduced to the nearest entire second in considering that the time and space are directly proportional for the short intervals considered, as for example:

Secs. Secs. In. In.

$$(930-0.03) : (1-0.03) : : 0.6 : x \therefore \frac{0.97}{0.927} 0.6 = 0.647 \text{ of an inch.}$$

or—

$$(1.937-0.03) : (2-0.03) : : 1.29 : x \therefore \frac{1.97}{1.907} 1.29 = 1.333 \text{ of an inch.}$$

Time of burning and length of train for successive seconds of the fuse scale at rest.

Observed data.			Reduced results for fuse scale.		
Length of train cut.	No. observation.	Time of burning.	Time.	Length.	Variation from mean.
Inches.		*Seconds.*	*Seconds.*	*Inches.*	*Inch.*
0.60	1	0.930	1	0.647	0.003
	2	0.942	1	0.638	0.006
0.62	3	0.994	1	0.624	0.020
	4	1.018	1	0.609	0.035
	5	0.974	1	0.637	0.007
*0.50	6	0.742	1	0.681	0.037
	†7	0.878	1	0.572	.....
	8	0.814	1	0.618	0.026
*1.00	9	1.476	1	0.671	0.027
	10	1.480	1	0.669	0.025
Mean of 9 observations.			1	0.644	0.021
1.29	1	1.937	2	1.333	0.000
	2	1.968	2	1.311	0.022
1.30	3	1.985	2	1.310	0.023
	4	1.984	2	1.316	0.017
	5	1.879	2	1.390	0.057
1.305	6	2.016	2	1.294	0.039
	7	1.974	2	1.322	0.011
	8	1.966	2	1.328	0.005
*1.50	9	2.199	2	1.362	0.029
	10	2.199	2	1.362	0.029
Mean of 10 observations.			2	1.333	0.023
1.99	1	2.928	3	2.039	0.034
2.00	2	3.038	3	1.975	0.030
	3	3.004	3	1.997	0.008
*2.00	†4	3.063	3	1.960	.....
	5	2.987	3	2.010	0.005
Mean of 4 observations..			3	2.005	0.019

* Pertains to the series reported May 11, 1892.
† Omitted.

Time of burning and length of train for successive seconds of the fuse scale at rest—Cont'd.

Observed data.			Reduced results for fuse scale.		
Length of train cut.	No. observation.	Time of burning.	Time.	Length.	Variation from mean.
Inches.		*Seconds.*	*Seconds.*	*Inches.*	*Inch.*
2.68	†1	3.819	4	2.808	.....
2.69	2	3.983	4	2.702	0.022
	3	3.990	4	2.697	0.037
2.694	4	3.917	4	2.752	0.018
	5	3.941	4	2.735	0.001
	6	3.887	4	2.773	0.039
2.705	7	4.086	4	2.648	0.086
*2.50	8	3.633	4	2.755	0.021
	9	3.620	4	2.765	0.031
*3.00	10	4.300	4	2.789	0.055
	11	4.409	4	2.720	0.014
Mean of 10 observations.			4	2.734	0.032
3.42	1	4.958	5	3.449	0.000
	2	5.053	5	3.392	0.057
	3	4.963	5	3.454	0.005
3.428	4	4.968	5	3.450	0.001
	†5	5.141	5	3.333	.....
	6	5.036	5	3.403	0.046
3.46	†7	5.240	5	3.301	.....
*3.50	8	5.004	5	3.497	0.048
	9	5.007	5	3.495	0.046
Mean of 7 observations..			5	3.449	0.029
*4.00	1	5.783	6	4.151	0.037
	2	5.719	6	4.197	0.009
*4.50	3	6.351	6	4.250	0.062
	4	6.499	6	4.153	0.035
Mean of 4 observations..			6	4.188	0.036
5.255	1	7.377	7	4.985	0.015
5.265	2	7.596	7	4.850	0.120
*5.000	3	6.976	7	5.017	0.047
	4	6.963	7	5.027	0.057
Mean of 4 observations.			7	4.970	0.060
	1	7.804	8	5.771	0.002
	2	7.782	8	5.788	0.005
	3	7.869	8	5.724	0.049
	4	7.767	8	5.800	0.027
5.630	5	7.833	8	5.751	0.022
	6	7.687	8	5.860	0.087
	†7	7.629	8	5.905	.....
	8	7.877	8	5.718	0.055
	9	7.697	8	5.852	0.079
	10	7.788	8	5.764	0.009
	11	7.524	8	5.849	0.076
*5.50	12	7.665	8	5.741	0.032
	13	7.724	8	5.697	0.076
*6.00	14	8.459	8	5.673	0.100
	15	8.224	8	5.836	0.063
Mean of 14 observations.			8	5.773	0.048
*6.50	1	8.962	9	6.528	0.034
	2	8.961	9	6.528	0.034
	†3	9.468	9	6.653	.....
*7.00	4	9.542	9	6.603	0.041
	5	9.559	9	6.589	0.027
Mean of 4 observations.			9	6.562	0.034
7.01	†1	9.766	10	7.178	.....
7.06	†2	9.956	10	7.091	.....
	†3	10.000	10	7.000	.....
7.11	†4	10.210	10	6.963	.....
*7.50	5	10.254	10	7.314	0.000
	6	10.254	10	7 314	0.000
Mean of 2 observations..			10	7.314	.....

* Pertains to the series reported May 11, 1892.
† Omitted.

Time of burning and length of train for successive seconds of the fuse scale at rest--Cont'd.

Observed data.			Reduced results for fuse scale.		
Length of train cut.	No observation.	Time of burning.	Time.	Length.	Variation from mean.
Inches.		*Seconds.*	*Seconds.*	*Inches.*	*Inch.*
*8.00	1	11.016	11	7.988	0.079
	2	10.804	11	8.146	0.079
Mean of 2 observations..			11	8.067	0.079
8.935	†1	12.434	12	8.622	.....
*8.50	2	11.562	12	8.823	0.040
	3	11.519	12	8.856	0.007
*9.00	4	12.116	12	8.914	0.051
	5	12.191	12	8.858	0.005
Mean of 4 observations..			12	8.865	0.026
*9.50	1	13.010	13	9.493	0.096
	2	12.752	13	9.685	0.096
Mean of 2 observations..			13	9.589	0.096
*10.00	1	13.620	14	10.280	0.051
	2	13.568	14	10.319	0.012
*10.50	3	14.190	14	10.359	0.028
	4	14.182	14	10.365	0.034
Mean of 4 observations..			14	10.331	0.031
10.70	†1	14.820	15	10.830	.....
10.90	†2	15.121	15	10.813	.....
	†3	15.094	15	10.832	.....
	4	14.724	15	11.204	0.118
	5	14.571	15	11.322	0.236
	6	15.099	15	10.928	0.158
*11.00	7	15.371	15	10.731	0.355
	8	14.974	15	11.016	0.076
	9	14.715	15	11.211	0.125
	10	14.801	15	11.192	0.106
Mean of 7 observations..			15	11.086	0.168

* Pertains to the series reported May 11, 1892.
† Omitted.

Record of firing with 3.2-inch B. L. rifle (steel), No. 18,

[Object of firing, test of Frankford Arsenal combination fuse lead

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Fuse cut at—	Shell burst at—	Recoil.
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Secs.*	*Yards.*	*Feet.*
	1588		3 12	Condemned shell, 1¼ inch band.	12 8 8 sand. 8 lead. 13 8	.....	.....	.....	9
	1589		3 12		12 2 shell. 2 lead. 4 powder. 1 0 fuse. 13 8	5 00	5	1,960	9
	1590		3 12		12 1 shell. 2 lead. 4 powder. 1 1 fuse. 13 8	5 00	5	*2,103	8
A. M...	1591		3 12		12 2 shell. 2 lead. 4 powder. 1 0 fuse. 13 8	4 00	5	1,965	8½
	1592		3 12		12 1 shell. 2 lead. 5 powder. 1 0 fuse. 13 8	3 45	5	1,970	8
	1593		3 12		12 2 shell. 2 lead. 4 powder. 1 0 fuse. 13 8	3 45	5	1,970 †1,966	9

Du Pont's I. K. H., lot 4; density, 1.725; granulation, 2,571.

Shell, lot 363; Watervliet Arsenal, special for fuse.

* This shot omitted from average.
† Mean of 4 shots. Time of burning above range, 4.8647 inches.

West Point Foundry, at Sandy Hook, N. J., February 24, 1892.

time train, to obtain relation between time of burning in air and at rest.]

Wind, strength and direction.	Observed time of flight.		Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	First watch, Lieut. C. B. Wheeler.	Second watch, H. V. Murphy.		
	Secs.	*Secs.*		
From left 90°, 14 miles an hour.	.....	.....	Warming charge; fired to sea....	Gun mounted on Buffington steel field carriage No. 17. Bow-spring brakes. Cannon friction primers (experimental), wax stoppers, January 23, 1892. Gun formerly had axial vent, with radial vent plugged, but bored out before this firing. Spindle and mushroom head formerly used in 3.2-inch B. L. rifle, No. 26, put in breechblock for this gun. Breech mechanism worked very hard. It was found that the breech mechanism for 3.2-inch B. L. rifles, Nos. 18 and 26 were not interchangeable, with exception noted above. Remaining velocity 974.2 foot seconds. Fired down the beach. Aimed so that shell would pass over left edge of 1-mile target. Poles placed in ground near line of fire, about 200 feet apart, extending from 1,760 to about 2,400 yards. Fuse cutter from Frankford Arsenal used, so made as to fit over fuse with an adjustable boring tool. Barometer, 30.54; thermometer, 38°. Burst of shell observed by Capt. R. Birnie, Ordnance Department; Lieut. O.M. Lissak, Ordnance Department.
	Lost..	5½	Number stamped on shell, 418....	
	5½	5½	Number stamped on shell, 416....	
	5	5	Number stamped on shell, 416....	
	5½	5½	Number stamped on shell, 479....	
	5	5	Number stamped on shell, 416....	

Record of firing with 3.2-inch B. L. rifle (steel), No. 18, West

[Object of firing, test of Frankford Arsenal combination fuse lead

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Fuse cut at—	Shell burst at—	Recoil.
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Secs.*	*Yards.*	*Feet.*
P. M..	1594	Du Pont's I. K. H., lot 4; density, 1.725; granulation, 2,571.	3 12	Condemned shell, 1¼-inch band.	13 0 8 sand. 13 8	.....	.....	.....	9
	1595		3 12	Shell, lot 363; Watervliet Arsenal, special for fuse.	12 1 shell. 2 lead. 5 powder. 1 0 fuse. 13 8	2 00	2	904	8
	1596		3 12		12 1 shell. 2 lead. 4 powder. 1 1 fuse. 13 8	1 45	2	895	8
	1597		3 12		12 2 shell. 5 powder. 1 1 fuse. 13 8	1 30	2	880	9
	1598		3 12		12 1 shell. 2 lead. 5 powder. 1 0 fuse. 13 8	1 30	2	854	8
	1599		3 12		12 2 shell. 2 lead. 4 powder. 1 0 fuse. 13 8	1 30	2	880 *883	8

* Mean of 5 shots. Time of burning above range, 1.8638 inches.

Record of firing with 3.2-inch B. L. rifle (steel), No. 18,

[Object of firing, test of powder previously proved and to determine velocity of projectile in

	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Elevation.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Feet.*	*Pounds.*
P. M	1623	Du Pont's I. K. H., lot 4; density, 1.725; granulation, 2,571.	3 12	Shell rebanded with band § inch from base.	12 14 10 sand. 13 8	1 00	.....	.....
	1624		3 12		13 8	.....	1,615 1,620	No. 8, less than 32,000.
	1625		3 12		13 8	.....	1,608 1,612	No. 8, 32,100.
	1626		3 12		13 8	.....	1,611 1,613	No. 8, less than 32,000.
	1627		3 12		13 8	.....	1,607 1,610	No. 8, 32, 000
	1628		3 12		13 8	.....	1,624 1,626 $50+\frac{1}{2}^{0}$	No. 8. 32,050

Point Foundry, at Sandy Hook, N. J., February 24, 1892—Continued.
time train, to obtain relation between time of burning in air and at rest.]

Wind, strength and direction.	Observed time of flight. First watch, Lieut. C. B. Wheeler.	Observed time of flight. Second watch, Lieut. W. M. Wood.	Observed time of flight. Third watch, H. V. Murphy.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	Secs.	*Secs.*	*Secs.*		
From left 90°, 14 miles an hour.	.....	.....	.....	Warming charge; fired to sea....	Gun mounted on Buffington steel field carriage No. 17. Bow-spring brakes. Poles placed in ground about 200 feet apart, extending about 600 yards on each side of 1,000-yards target. Remaining velocity, 1,245.2 foot-seconds. Fired down the beach. Aimed so that shell would pass over left edge of 1,000-yards target. Firing on March 9, 1892, with projectiles of the same weight, and having bands ⅝ inch from the base, gave an initial velocity mean of five shots—1,635 feet per second. The calculated remaining velocity at 883 yards is 1,245.2 feet per second. Time of flight corresponding to this range, 1.8638 seconds. The calculated remaining velocity at 1,966 yards is 974.2 feet per second. The time of flight for this range is 4.8647 seconds. Barometer, 30.54; thermometer, 38°. Burst of shell observed by Capt. R. Birnie, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
	2¼	.....	2¼	Number stamped on shell, 392....	
	2	.....	2	Number stamped on shell, 375....	
	2	2	2	Number stamped on shell, 379....	
	2	2	2	Number stamped on shell, 379....	
	2	2	2¼	Number stamped on shell, 379....	

West Point Foundry, at Sandy Hook, N. J., March 9, 1892.
connection with firing with Frankford Arsenal combination fuse with lead time train.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
9½	From rear and right 20°, 10 miles an hour.	Warming charge; fired to sea.....	Gun mounted on Buffington steel field carriage No. 17. Bow-spring brakes. Cannon friction primers (experimental), wax stoppers, January 23, 1892. Fired into field butt. Copper cylinders of 3,200 pounds initial compression and tables of 1890. Calculated initial velocity equals 1,635 foot-seconds. Barometer, 29.52; thermometer, 54°. Velocities and pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
8½		.....	
10		.....	
10		.....	
9½		.....	
10		.....	

Record of firing with 3.2-inch B. L. rifle (steel), No. 18,

[Object of firing, test of Frankford Arsenal combination fuse lead time

	No of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Shell burst at —	Elevation.	Fuse cut at—	Recoil.
			Lbs. Oz.		*Lbs. Oz.*	*Yards.*	° ′	*Secs.*	*Feet.*
P. M.	1633	Du Pont's L. K. H., lot 27; density, 1.725; granulation, 2,605.	3 12	Shell, lot 284.	13 0 8 sand. 13 8	.....	5 30	.....	12
	1634		3 12	Shell re-banded.	13 0 8 sand. 13 8	.....	5 45	.....	13
	1635		3 12	Shell, lot 366; special for Frankford Arsenal combination fuse.	13 2½ shell and fuse. 5½ powder. 13 8	3,125	5 35	8	12
	1636		3 12		13 3 shell and fuse. 5 powder. 13 8	3,162	5 35	8	13
	1637		3 12		13 3 shell and fuse. 5 powder. 13 8	3,204	5 40	8	13
	1638		3 12		13 2 shell and fuse. 5½ powder. ½ charcoal. 13 8	.....	5 55	8	12
	1639		3 12		13 2 shell and fuse. 5½ powder. ½ charcoal. 13 8	3,102	5 55	8	13
	1640		3 12		13 1½ shell and fuse 6 powder. ½ charcoal. 13 8	3,074	5 55	8	13
						*3,133			

* Mean range.

West Point Foundry, at Sandy Hook, N. J., April 4, 1892.

train to obtain relation between time of burning in air and at rest.]

Wind, strength and direction.	Observed time of flight.		Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	First watch, Lieut. W. W. Gibson.	Second watch, H. V. Murphy.		
	Secs.	*Secs.*		
From right and rear 15°, 4 miles an hour.	.....	.....	Sighting shot. Struck the ground about 500 yards in rear of target.	Gun mounted on Buffington steel field carriage No. 1. Bow-spring brakes. Cannon friction primers (experimental), wax stoppers, January 23, 1892. Fired down the beach. Aimed so that shell would pass over center of 3,000-yards target. Mean of calculated time of flight equals 8.66 seconds. Frankford Arsenal fuse cutter used. Remaining velocity at mean range, 852.6 foot-seconds. Time of burning, mean range, 8.5524 foot-seconds. This is considering barometer and thermometer. Quadrant used to give elevation. Telescopic sight used. Breechblock closed with difficulty throughout the firing. Fuse bored after being screwed in shell. Mean range equals 3,133.4 yards. Mean instrumental velocity for three shots equals 1,618 foot-seconds; corresponding to muzzle velocity of 1,638 foot-seconds. Barometer, 30.08; thermometer, 75°. Burst of shell observed by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
	.....	.....	Sighting shot. Struck the ground about 800 yards in rear of target.	
	8½	Lost.	Calculated time of flight, 8.64 seconds; calculated remaining velocity, 843 foot-seconds.	
	.....	.....	Burst of shell not visible from firing point. Calculated time of flight, 8.77 seconds. Calculated remaining velocity, 839 foot-seconds.	
	.....	.....	Burst of shell not visible from firing point. Calculated time of flight, 8.90 seconds. Calculated remaining velocity, 835 foot-seconds.	
	.....	.....	Shell broke up in gun.....	
	8½	8⅓	Calculated time of flight, 8.54 seconds. Calculated remaining velocity, 846 foot-seconds.	
	8½	8½	Calculated remaining velocity, 849 foot-seconds. Calculated time of flight, 845 foot-seconds.	
	†8.417	†8.1875		

†Mean.

Record of firing with 3.2-inch B. L. rifle (steel), No 18,

[Object of firing, to obtain velocities and pressure in experiments connected

	No. of fire.	Powder.		Projectile.		Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.		
			Lbs. Oz.		*Lbs. Oz.*	*Feet.*	*Pounds.*
A. M	1641	Du Pont's I. K. H., lot 27; density, 1.725; granulation, 2.605.	3 12	Shell, lot 300, 1¼ band.	13 0	.....	.....
	1642		3 12	Shell rebanded with band ⅝-inch from base.	13 8	Lost. 1,616	.....
	1643		3 12		13 8	Lost. 1,621	No. 8, 33.933
	1644		3 12		13 8	Lost. 1,616	.....
	1645		3 12		13 8	1,595 1,595	.....
						50+½	.....

Record of firing with 3.2-inch B. L. rifle (steel), No. 18,

[Object of firing, test of Frankford Arsenal combination fuse lead

	No. of fire.	Powder.		Projectile.		Shell burst at—	Elevation.	Fuse cut at—
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs. Oz.*	*Yards.*	° ′	*Secs.*
P. M	1696	Du Pont's I. K. H., lot 29; density, 1.725; granulation, 2,405.	3 12	Shell, lot 374.	13 0 8 sand. 13 8	.....	5 55	.....
	1697		3 12	Special for Frankford Arsenal combination fuse.	13 1 including fuse. 7 powder. 13 8	3,036	5 50	8
	1698		3 12		13 1 including fuse. 7 powder. 13 8	3,035	5 50	8
	1699		3 12		13 2 including fuse. 6 powder. 13 8	3,053	5 50	8
	1700		3 12		13 1 including fuse. 7 powder. 13 8	3,038	5 50	8
	1701		3 12	Shell, lot 378; special	13 1 including fuse. 7 13 8	*3,016	5 50	8
	1702		3 12		13 1 including fuse. 7 13 8	3,043	5 50	8
						† 3,041		

* This shot omitted from mean.

West Point Foundry, at Sandy Hook, N. J., April 5, 1892.

with Frankford Arsenal combination time fuse with lead time train.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
9	From rear and right, 6 miles an hour.	Warming charge; fired to sea	Gun mounted on Buffington steel field carriage No. 1. Bow-spring brakes. Cannon friction primers (experimental), wax stoppers, January 23, 1892.
10		.....	Elevation, zero. Fired into field butt.
10		.....	Copper cylinders of 32,000 pounds initial compression and tables of 1890.
11		First primer failed	1.618 mean of 3 shots. Barometer, 30.09; thermometer, 65°.
10		.....	Firing conducted by Lieut. W. W. Gibson, Ordnance Department, assistant proof officer.
.....		.....	

West Point Foundry, at Sandy Hook, N. J., May 2, 1892.

time train, to obtain relation between time of burning in air and at rest.]

Recoil.	Wind, strength and direction.	Observed time of flight.		Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
		First watch, Lieut. C. B. Wheeler.	Second watch, H. V. Murphy.		
Feet.		*Secs.*	*Secs.*		
12	From 2 to 3, 8 miles an hour; from 3 to 4, 13 miles an hour; from 4 to 5, 14 miles an hour.	.....	.....	Sighting shot. Struck the ground about 230 yards in rear of target.	Gun mounted on Buffington steel field carriage No. 1. Bow-spring brakes. Cannon friction primers (experimental), wax stoppers, January 23, 1892. Fired down the beach. Aimed so that shell would pass over center of 3,000-yards target. Frankford Arsenal fuse cutter used. Quadrant used to give elevation. Telescopic sight used. Difficulty in closing breechblock, a mallet being used. Mean range, 3,041 yards. Firings with I. K. H. powder, lot 29, gave a mean instrumental velocity of 1,639.5 foot-seconds; corresponding to an initial velocity of 1,659.5 foot-seconds. Calculated time of burning for mean range, 8.1352 seconds. Remaining velocity at mean range, 870.85 foot-seconds. Barometer, 29.96; thermometer, 78°. Fuses cut by Lieut. C. B. Wheeler, Ordnance Department. Burst of shell observed by Capt. F. Heath, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department.
13		$8\frac{1}{4}$	$8\frac{1}{4}$	.....	
12		$8\frac{1}{2}$	$8\frac{1}{2}$	.....	
13		$8\frac{1}{2}$	$8\frac{1}{2}$	.....	
12		$8\frac{1}{4}$	$8\frac{1}{4}$	.....	
12	From right 90 degrees; 8 miles an hour.	*8	*8	.....	
12		$8\frac{3}{8}$	$8\frac{1}{2}$	.....	
		† 8.375	† 8.40		

† Mean.

Record of firing with 3.2-inch B. L. rifle (steel), No. 18,

[Object of firing, to obtain velocities and pressures in connection with

	No. of fire.	Powder.		Projectile.		Elevation.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Feet.*	*Pounds.*
A. M.	1703	Du Pont's I. K. H., lot 29; density, 1,725; granulation, 2,405.	3 12	Shell, lot 374.	13 0 8 sand. 13 8	0 05	1,623 1,620	No. 8, 34, 866
	1704		3 12		12 15 9 sand. 13 8	0 05	1,638 1,638	No. 8, 34, 633
	1705		3 12		13 0 8 sand. 13 8	0 05	1,643 1,643	No. 8, 34, 757
	1706		3 12		13 0 8 sand. 13 8	0 05	1,638 1,638	No. 8, 34, 355
	1707		3 12		13 0 8 sand. 13 8	0 05	1,642 1,636	No. 8, 34, 800
							50+$\frac{150}{2}$	

Record of firing with 3.2-inch B. L. rifle (steel), No. 32,

[Object of firing, test of Frankford Arsenal combination fuse, to

Date.	No. of fire.	Powder.		Projectile.		Shell burst at—	Elevation.	Fuse cut at—	Recoil.
		Kind.	Weight.	Kind.	Weight.				
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Yards.*	° ′	*Secs.*	*Feet.*
June 30	120	Du Pont's L. K. H., lot 56; density, 1.725; granulation, 2,840.	3 12	Shell, lot 374.	13 0 8 sand. 13 8	.....	1 30	.....	3½
June 30	121		3 12		13 0 8 sand. 13 8	.....	1 30	.....	4
June 30	122		3 12		13 0 8 sand. 13 8	.....	1 30	.....	4
June 30	123		3 12	Shell, lot 391; special for Frankford Arsenal combination fuse.	13 3 5 including fuse. powder. 13 8	.....	1 30	3	4
June 30	124		3 12		13 3 5 including fuse. powder. 13 8	1,397	2 20	3	4

West Point Foundry, at Sandy Hook, N. J., May 3, 1892.

firing of Frankford Arsenal combination time fuse with lead time train.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
10	From front, 10 miles an hour.	Warming charge.....	
11		.....	Gun mounted on Buffington steel field carriage No. 1. Bow-spring brakes. Cannon friction primers (experimental), wax stoppers, January 23, 1892. Fired into field butt, No. 2.
11		.....	Copper cylinders of 32,000 pounds initial compression and tables of 1890. Mean instrumental velocity 1,639.5 foot-seconds; corresponding to an initial velocity of 1,659.5 foot-seconds.
11		.....	Barometer, 30.15; thermometer, 59°. Velocities and pressures taken by Lieut. C. B. Wheeler, Ordnance Department. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
12		.....	

Watervliet Arsenal, at Sandy Hook, N. J., June 30, 1892.

obtain relation between time of burning in air and at rest.]

Wind, strength and direction.	Observed time of flight. First watch, Lieut. C. B. Wheeler.	Observed time of flight. Second watch, H. V. Murphy.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	Secs.	*Secs.*		
From 10 to 11 right 90°, 14 miles an hour; from 11 to 11.30 front 0°, 8 miles an hour.	.....	.....	Sighting shot and warming charge. Struck 500 yards beyond 1-mile target.	Gun mounted on Buffington steel field carriage. Cannon friction primers, model 1887; Frankford Arsenal, January, 1891.
	.....	.....	Sighting shot.....	Fired down the beach. Aimed to the left of 1-mile target. Gun standing on hard sand near 12-inch B. L. rifle. Fuse bored before being screwed into shell.
	.....	.....	Sighting shot.....	Firings with I. K. H. powder, lot 56, gave a mean instrumental velocity of 1,641 foot-seconds; corresponding to an initial velocity of 1,661 foot-seconds.
	.....	.....	Shell struck the ground before fuse exploded.	Calculated time of burning for mean range, 3.0959 seconds. Remaining velocity at mean range, 1,132.7 foot-seconds. Fuses cut by Lieut. C. B. Wheeler, Ordnance Department.
	$3\frac{1}{8}$	$3\frac{1}{2}$	.....	French quadrant used to give elevation. Telescopic sight used. Barometer, 30.11; thermometer, 80°; humidity, 72.

Record of firing with 3.2-inch B. L. rifle (steel), No. 32, Watervliet

[Object of firing, test of Frankford Arsenal combination fuse, to

Date.	No. of fire.	Powder. Kind.	Powder. Weight.	Projectile. Kind.	Projectile. Weight.	Shell burst at—	Elevation.	Fuse cut at—	Recoil.
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Yards.*	° ′	*Secs.*	*Feet.*
June 30	125	density, 1.725; granulation, 2,840.	3 12	Shell, lot 391; special for Frankford Arsenal combination fuse.	13 2½ including fuse. 5½ powder. 13 8	1,422	2 20	3	4
June 30	126		3 12		13 2½ including fuse. 5½ powder. 13 8	1,425	2 20	3	4
June 30	127		3 12		13 3 including fuse. 5 powder. 13 8	1,358 *1,401	2 20	3	4
P. M.									
July 5	128		3 12	Shell, lot 374.	13 3 5 sand. 13 8	.....	4 05	.....	.....
July 5	129		3 12		13 2 6 sand. 13 8	.....	4 30	.....	.....
July 5	130	Du Pont's I. K. H., lot 56;	3 12	Special for Frankford Arsenal combination fuse.	13 3 including fuse. 5 powder. 13 8	2,403	4 30	6	.....
July 5	131		3 12		13 3 including fuse. 5 powder. 13 8	†2,556	4 30	6	.....
July 5	132		3 12		13 3½ including fuse. 4½ powder. 13 8	2,417	4 30	6	.....
July 5	133		3 12		13 2½ including fuse. 5½ powder. 13 8	2,440	4 30	6	.....
July 5	134		3 12	Shell, lot 391;	13 3 including fuse. 5 powder. 13 8	2,468 *2,432	4 30	6	.....

* Mean range.

† This shot omitted from mean range.

Arsenal, at Sandy Hook, N. J., from June 30 to July 5, 1892.

obtain relation between time of burning in air and at rest.]

Wind, strength and direction.	Observed time of flight.		Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	First watch, Lieut. C. B. Wheeler.	Second watch, H. V. Murphy.		
	Secs.	*Secs.*		
From 10 to 11 right 90°, 14 miles an hour; from 11 to 11.30, front 0°, 8 miles an hour.	3¼	3¼		Gun mounted on Buffington steel field carriage. Cannon friction primers, model 1887; Frankford Arsenal, January, 1891. Fired down the beach. Aimed to the left of 1-mile target. Gun standing on hard sand near 12-inch B. L. rifle. Fuse bored before being screwed into shell. Firings with I. K. H. powder, lot 56, gave a mean instrumental velocity of 1,641 foot-seconds; corresponding to an initial velocity of 1,661 foot-seconds. Calculated time of burning for mean range, 3.0959 seconds. Remaining velocity at mean range, 1,132.7 foot-seconds. Fuses cut by Lieut. C. B. Wheeler, Ordnance Department. French quadrant used to give elevation. Telescopic sight used. Barometer, 30.11; thermometer, 80°; humidity, 72.
	3½	3⅜		
	3	3		
	*3.219	3.281		
From front, 3 to 4, 11 miles.	.....	.....	Sighting shot.....	
	.....	.....	Sighting shot.....	
From front, 1 to 2, 12 miles; 2 to 3, 12 miles; 3 to 4, 11 miles.	6⅜	6⅜		Cannon friction primers, model 1887; Frankford Arsenal, January, 1891. Fired down the beach. Aimed at left edge of 1-mile target; gun standing on hard sand near 12-inch B. L. rifle. Firings with I. K. H. powder, lot 56, gave a mean instrumental velocity of 1,641 foot-seconds; corresponding to an initial velocity of 1,661 foot-seconds. Fuse bored by Lieut. C. B. Wheeler before being screwed into shell. Calculated time of burning mean range, 6.395 seconds. Remaining velocity at mean range, 941 foot-seconds. French quadrant used to give elevation. Telescopic sight used. Barometer, 30.43; thermometer, 78°; humidity, 63.
	*7	*7		
	6½	6⅜		
	6⅓	6¼		
	6¾	6⅛		
	‡6.4375	6.375		

‡ Mean.

Record of firing with 3.2-inch B. L. rifle (steel), No. 32,

[Object of firing, test of Frankfort Arsenal combination fuse, to

Date.	No. of fire.	Powder.		Projectile.		Shell burst at—	Elevation.	Fuse cut at—	Recoil.
		Kind.	Weight.	Kind.	Weight.				
A. M.			*Lbs. Oz.*		*Lbs. Oz.*	*Yards.*	° ′	*Secs.*	*Feet.*
July 6	135	Du Pont's I. K. H., lot 56; density, 1.725; granulation, 2,840.	3 12	Shell, lot 374.	13 2 6 sand. 13 8	.....	6 30	.....	.....
July 6	136		3 12	Shell lot, 391; special for Frankford Arsenal combination fuse.	13 3 including fuse. 5 powder. 13 8	3,468	6 45	9	12
July 6	137		3 12		13 2½ including fuse. 5½ powder. 13 8	3,465	6 45	9	12
July 6	138		3 12		13 3 including fuse. 5 powder. 13 8	.....	6 45	9	12
July 6	139		3 12		13 3 including fuse. 5 powder. 13 8	3,480	6 45	9	12
July 6	140		3 12		13 3 including fuse. 5 powder. 13 8	3,433 *3,461	6 45	9	13
P. M. July 6	141		3 12	Shell, lot 374.	13 3 5 sand. 13 8	.....	9 00	.....	12
July 6	142		3 12	Shell lot, 391; special for Frankford Arsenal combination fuse.	13 3 including fuse. 5 powder. 13 8	4,189	9 33	12	12
July 6	143		3 12		13 3 including fuse. 5 powder. 13 8	4,237	9 33	12	12
July 6	144		3 12		13 3 including fuse. 5 powder. 13 8	4,228	9 33	12	12
July 6	145		3 12		13 3 including fuse. 5 powder. 13 8	4,239	9 33	12	12
July 6	146		3 12		13 3 including fuse. 5 powder. 13 8	4,230 *4,225	9 33	12	12

* Mean range.

Watervliet Arsenal, at Sandy Hook, N. J., July 6, 1892.

obtain relation between time of burning in air and at rest.]

Wind, strength and direction.	Observed time of flight.		Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
	First watch, Lieut. C. B. Wheeler.	Secondwatch, H. V. Murphy.		
	Secs.	*Secs.*		
From right, 10 to 11, 2 miles an hour; 11 to 12, 4 miles an hour.	.....	.....	Sighting short	
	9¾	10		Gun mounted on Buffington steel field carriage. Cannon friction primers, model 1887; Frankford Arsenal, January, 1891. Fired from platform on fort wall. Aimed so that shell would pass over left edge of 3,000-yards target. Fuse bored before being screwed in shell. Firings with I. K. H. powder, lot 56, gave a mean instrumental velocity of 1,641 foot-second; scorresponding to an initial velocity of 1,661 foot-seconds. Remaining velocity at mean range, 817.4 foot-seconds. French quadrant used to give elevation; telescopic sight used. Fuse cut by Lieut. C. B. Wheeler, Ordnance Department. Calculated time of burning for mean range, 9.6921 seconds. Barometer, 30.55; thermometer, 74°; humidity, 58.
	9¾	9⅝		
	.....	.....	Shell wabbled in flight; no burst visible.	
	10	10		
	9¾	10		
	†9.8125	9.906		
From 3 to 4, 9 miles an hour; from 4 to 4:30, 4 miles.	.....	.....	Sighting shot	
	13	13		Cannon friction primers, model 1887; Frankford Arsenal, January, 1891. Fired from platform on fort wall. Aimed so that shell would pass over left edge of 3,000-yards target. French quadrant used to give elevation. Telescopic sight used. Firings with I. K. H, lot 56, gave a mean instrumental velocity of 1,641 foot-seconds; corresponding to an initial velocity of 1,661 foot-seconds. Fuse bored before being screwed in shell; Frankford Arsenal fuse cutter used. Fuse cut by Lieut. C. B. Wheeler, Ordnance Department. Calculated time of burning for mean range, 12.624 seconds. Remaining velocity at mean range, 745.9 foot-seconds. Burst of shell observed by Lieut. O. M. Lissak, Ordnance Department. Barometer, 30.63; thermometer, 76°; humidity, 52. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
	13¼	13¼		
	13¼	Lost		
	13	13¼		
	13¼	13⅜		
From right and front 45°;	†13.15	13.15625		

† Mean.

Record of firing with 3.2-inch B. L. rifle (steel), No. 32,

[Object of firing, to determine velocities and pressures in

	No. of fire.	Powder.		Projectile.		Depression.	Instrumental velocity, 125 feet from muzzle.	Pressure per square inch of bore.
		Kind.	Weight.	Kind.	Weight.			
			Lbs. Oz.		*Lbs. Oz.*	° ′	*Feet.*	*Pounds.*
A. M	110	Du Pont's I. K. H., lot 56; density, 1.725; granulation, 2,840.	3 12	Shell, lot 374.	13 4 4 sand. 13 8	0.05	{ 1,625 1,617 }	No. 3, 32, 860
	111		3 12		13 2 6 sand. 13 8	0.05	{ 1,643 1,637 }	No. 3, 32, 470
	112		3 12		13 0 8 sand. 13 8	0.05	{ 1,648 1,639 }	No. 3, 32, 720
	113		3 12		13 0 8 sand. 13 8	0.05	{ 1,644 1,635 }	No. 3, 33, 060
							$50+\frac{150}{2}$	

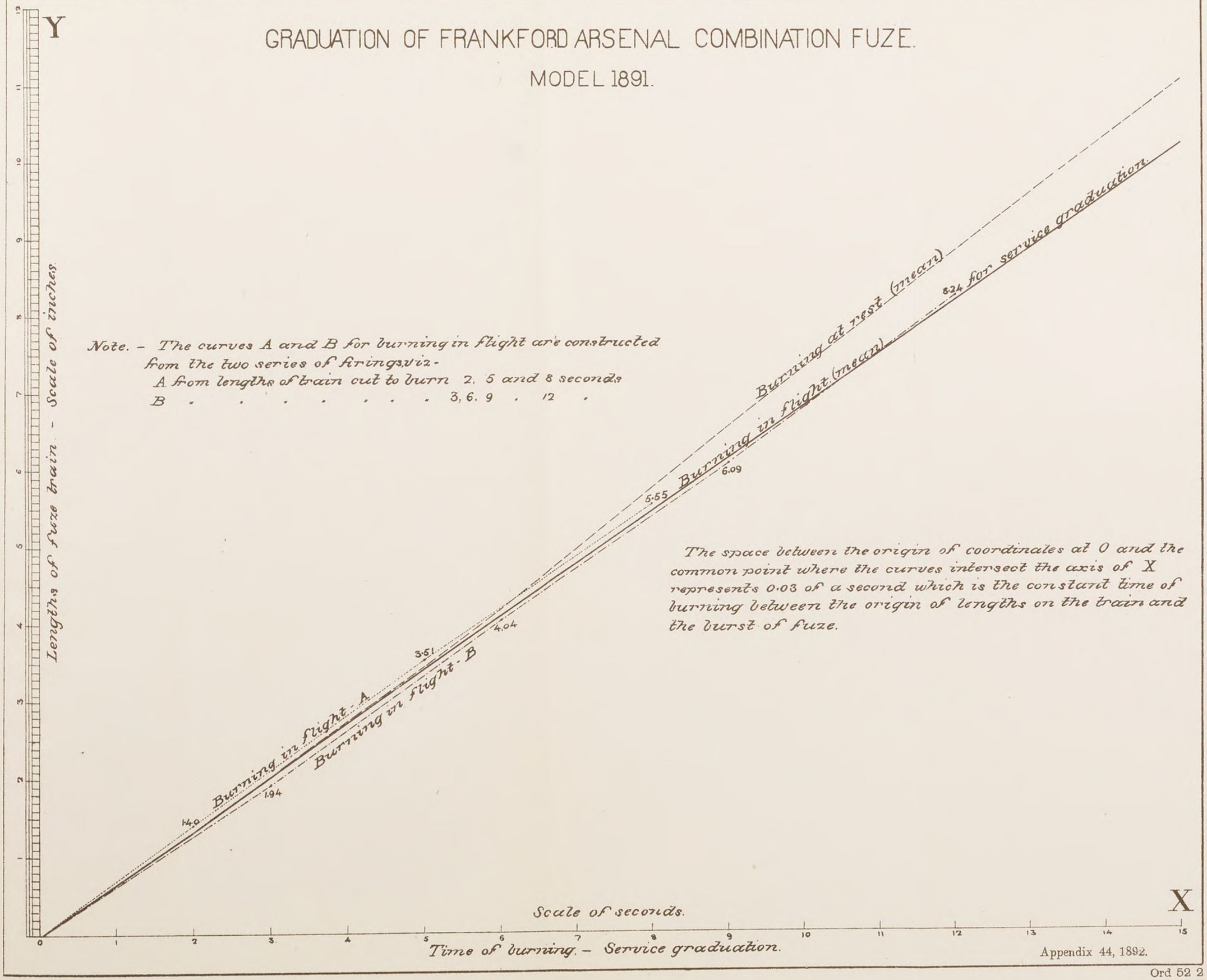
Watervliet Arsenal, at Sandy Hook, N. J., June 16, 1892.

connection with experiments with Frankford Arsenal combination fuse.]

Recoil.	Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
Feet.			
12	From front, 10 miles an hour.	.....	Gun mounted on Buffington steel field carriage No. 5. Bow-spring brakes. Cannon friction primers, model 1887; Frankford Arsenal, January, 1890. Fired into field butt, No. 2. Copper cylinders of 32,000 pounds initial compression and tables of 1892. Mean instrumental velocity, 1,641 foot-seconds; corresponding to muzzle velocity, 1,661 foot-seconds. Barometer, 30.28; thermometer, 68°; humidity, 70. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
13		.....	
11		.....	
11		.....	

GRADUATION OF FRANKFORD ARSENAL COMBINATION FUZE.

MODEL 1891.



Note. - The curves A and B for burning in flight are constructed from the two series of firings, viz-
A from lengths of train cut to burn 2, 5 and 8 seconds
B . . . . . 3, 6, 9 . 12 .

The space between the origin of coordinates at 0 and the common point where the curves intersect the axis of X represents 0.03 of a second which is the constant time of burning between the origin of lengths on the train and the burst of fuze.

Time of burning. - Service graduation.

Appendix 44, 1892.

APPENDIX 45.

REPORTS ON CUTTER AND CRUSHER GAUGES FOR SMALL ARMS AND PRESSURES OF SMOKELESS POWDER.

(1 plate.)

[Second indorsement.]

ORDNANCE OFFICE,
Washington, September 3, 1892.

Respectfully referred to the commanding officer Springfield Armory for his information. It is desired that hereafter pressure gauges used shall be of the crusher pattern and that similar gauges shall be used at the armory and Frankford Arsenal.

CHARLES SHALER,
Capt., Ord. Dept., U. S. A., Acting Chief of Ordnance.

(2370 C–'92.)

SPRINGFIELD ARMORY,
Springfield, Mass., May 10, 1892.

SIR: I have the honor to forward herewith two reports of Capt. S. E. Blunt, dated respectively March 31, 1892, and April 22, 1892, upon experiments made at this armory, by my direction, with the Rodman cutter and the English crusher gauges, fitted to determine the pressure in small arms.

A description of the two gauges by Capt. Blunt is also forwarded, and some remarks by the same officer on the test made by him in December, 1891, of Troisdorf smokeless powder.

Most of the pressures taken at the armory prior to March of this year had been with the Rodman gauge, and though some trials had been made with a crusher gauge, it appeared that no definite conclusion had been reached. The object of the experiments now reported was to determine which gauge gave the most reliable results.

Trials were made with both gauges without initial cut or compression and with initial cuts and compressions produced by different loads.

With a low pressure the two gauges differed about 4,000 pounds, but as the pressure increased they separated more and more till when a pressure of about 60,000 pounds was reached the difference was 20,000 pounds.

With the cutter gauge, when the indicated pressure was from 48,000 pounds to about 55,000 pounds, the same result, practically, was obtained if no initial cut was made or one was given by a load of 53,250 pounds or 33,750 pounds.

With the crusher gauge the indicated pressure decreased from where no initial compression was given up to where one was used that fell slightly below the probable correct pressure.

Whatever initial cut might be given, the cutter by the force of powder always increased the cut; whereas, in the other gauge, coppers that received an initial compression indicated little or no reduction when the compression was near to or above what might be considered the actual force.

From this series of experiments it would appear that the crusher gauge is the more reliable of the two; that throughout it indicates lower pressures than does the cutter gauge, and that for uniformly increasing pressures the indications by the latter gauge increase more rapidly than do those by the former.

The crusher gauge will hereafter be used at this armory in all tests. It is believed that the high pressures heretofore obtained here and regarded as reliable have not been correct and have been excessive.

Respectfully, your obedient servant,

A. MORDECAI,
Colonel, Ord. Dept., U. S. Army, Commanding.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

(2370–'92.)

SPRINGFIELD ARMORY,
Springfield, Mass., March 31, 1892.

SIR: In accordance with your verbal directions, I have the honor to submit the following report of trials made for determining the pressure of the powder gas in the chamber of the caliber .30 Springfield barrel.

The instrument used for many years at this armory has been the Rodman external pressure gauge, with circular cutter, as described in the report of the Chief of Ordnance for 1880, page 178; with the caliber .45 barrel the area of the piston was one-tenth of a square inch, and for the early pressures, after caliber .30 barrels had been made here, the same diameter was preserved.

With black powder the velocities found in the pressure barrel and in a similar barrel assembled as a complete gun, but without pressure-gauge attachment, were not greatly different, and it could consequently be inferred that the pressures were also similar; but when tests of smokeless powders were made marked differences in velocities developed.

In a report of June 10, 1890 (Report of the Chief of Ordnance for 1890, page 199), the causes which it was believed occasioned these discrepancies and the measures taken in endeavoring to overcome them are explained, the principal of the latter being the reduction of the area of the piston to one-thirtieth of a square inch. While the differences were thus greatly reduced yet an entire correspondence was not obtained, the velocities in the gun still exceeding those for similar charges in the pressure barrel, this excess being augmented as the absolute velocity increased and being for the higher velocities about 40 or 50 feet. It is therefore probable that the pressure in the barrel is still slightly less than in the gun.

The observed velocities accorded fairly well with those reported in tests of similar powders abroad; the pressures indicated by the method followed were, however, considerably greater. Doubt, therefore, arose as to the correctness of these absolute pressures, but as for *comparative* tests of different powders giving the same velocities the system afforded a method of determining which gave the greater pressure. It

was still followed, though the recorded pressure was believed to be (by a constant multiplier for the same pressure) greater than that actually existing.

With a piston of one-thirtieth of a square inch area and the cutter used at the armory, the pressure as determined by the Benton dynamometer (similar to that described in ordnance note, No. 66, of May 20, 1877) was 60,000 pounds per square for a cut 0.719 inch in length. The greatest depth of such a cut is 0.0437 inch, and the piston must therefore have traveled over a path of that length (measured from the surface of the copper) in producing it.

To produce a similar cut in the pressure barrel, the piston must again move over this path, but as its velocity will now be vastly in excess of what it had in the dynamometer an energy will be developed, from a lower absolute pressure, sufficient to give this cut; and it is evident too that this proportionate error must be greater as the motion of the piston increases, that is, as the pressures increase, and while the indications from black powder may not be greatly in error those for large charges of smokeless powder must be proportionately in excess of the reality.

In the fall of 1890, a gun similar to that used in England in determining pressures was constructed at the armory; this used at the base of the cartridge a copper cylinder to which initial compression had been given. A number of these cylinders, half an inch in length, 0.4262 inch exterior diameter, with an axial perforation 0.15 inch in diameter, giving therefore a sectional area of $\frac{1}{8}$ of a square inch, were made here and compressed at Watertown Arsenal in January, 1891, with applied loads of 3,750, 5,000, and 6,250 pounds, equivalent to 30,000, 40,000, and 50,000 pounds respectively per square inch.

Afterwards, when measured here, those compressed with the two lighter loads were found to be then but (on an average) 0.0005 of an inch less than their original length, and those compressed by the heaviest load to be shorter by amounts varying between 0.004 inch and 0.055 inch. Evidently after the pressure had been removed the coppers returned in a greater or less degree toward their length before compression.

The capacity of the dynamometer at the armory not permitting the desired initial compression to be given a copper of this area of cross section, it became necessary to apply the requisite loads to the coppers at Watertown in advance of their use here, but as they did not thereafter remain of the original reduced length it was deemed they were worthless for the purpose proposed; further efforts in this direction were therefore discontinued.

The cylinders just mentioned had been made from some bar copper, obtained in 1881 from James G. Moffet; it presumably, according to the order then given, had been annealed by the manufacturer. The cylinders were not annealed here after making.

In March, 1891, a further supply of copper was ordered from James G. Moffet, New York, in bars 26 inches long, $\frac{3}{4}$ inch wide, and $\frac{45}{100}$ inch thick, to be of "uniform density, sound and seamless, and well annealed after final rolling." It was used subsequently in determining pressures according to the cutter system.

Last December, with the approval of the commanding officer, I had prepared from this copper some cylinders 0.5 inch long and 0.206 inch in diameter, having, therefore, a cross section of $\frac{1}{30}$ of a square inch. These were so made that the axis of the cylinders should accord with that of the bar from which they were turned, and every care was taken to have them exact in size.

When completed, they were thoroughly and uniformly annealed and then gauged. They were subsequently subjected, in the dynamometer, to the pressures, and with the results shown in the following table:

Measurements of annealed copper cylinders.

Cylinders 0.5 inch by 0.206 inch.	No 1.	No. 2.	No. 3.	No. 4.	No. 5.
Applied load, pounds	1,475	1,775	1,775	1,975	1,975
Corresponding pressure, per square inch	44,250	53,250	53,250	59,250	59,250
Original length, February 9	0.4999	0.5000	0.5000	0.5000	0.4999
After application of load. Length on—					
February 9, 1892	0.4093	0.3849	0.3832	0.3641	0.3659
February 10, 1892	0.4091	0.3848	0.3830	0.3641	0.3660
February 11, 1892	0.4091	0.3848	0.3830	0.3640	0.3657
February 15, 1892	0.4090	0.3846	0.3829	0.3640	0.3657
February 17, 1892	0.4090	0.3847	0.3828	0.3640	0.3657
March 5, 1892	0.4090	0.3847	0.3827	0.3638	0.3657

The cylinders of January, 1891, not retaining for even a few days the lengths given them by compression, while these latter ones even after an interval of nearly four weeks had changed but very slightly, it must be concluded either that the copper first used was originally not suitable or else that the defect developed must be ascribed to the omission of annealing after the cylinders had been completed.

The present cylinders would appear, however, to be well adapted to the purpose for which they were intended.

A large number of these cylinders were then compressed in the Benton dynamometer at this armory with applied loads running from 625 to 1,975 pounds, corresponding to pressures per square inch between 18,750 and 59,250 pounds.

Some of the coppers were also sent to Watertown Arsenal and there subjected to compression in the testing machine. The measurements of these two sets of coppers after compression are given in the two following tables:

Annealed coppers compressed by Springfield Armory dynamometer.

[Original length, 0.5000 inches.]

Applied loads.	Corresponding pressure per square inch.	Length after compression.								
		No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	No. 7.	No. 8.	Mean.
	Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
625	18,750	.4781	.4765	.4771	.4762	.4796	.....	.....	.....	0.4775
675	20,250	.4734	.4751	.4742	.4733	.4720	.4726	.4732	.4746	0.4735
725	21,750	.4703	.4699	.4680	.4704	.4692	.4687	.....	.....	0.4694
775	23,250	.4676	.4652	.4668	.4671	.4658	.....	.....	.....	0.4665
875	26,250	.4601	.4605	.4585	.4607	.4578	.4576	.4583	.4570	0.4588
925	27,750	.4559	.4564	.4550	.4543	.4575	.....	.....	.....	0.4558
975	29,250	.4521	.4526	.4505	.4514	.4508	.4518	.4508	.4508	0.4513
1,025	30,750	.4478	.4462	.4463	.4486	.4493	.....	.....	.....	0.4476
1,075	32,250	.4441	.4432	.4426	.4461	.4458	.....	.....	.....	0.4444
1,125	33,750	.4403	.4412	.4403	.4398	.4385	.4388	.4380	.4379	0.4393
1,175	35,250	.4340	.4339	.4364	.4341	.4350	.4335	.4340	.....	0.4344
1,225	36,750	.4321	.4330	.4318	.4324	.4326	.4306	.....	.....	0.4321
1,275	38,250	.4264	.4258	.4281	.4279	.4286	.4284	.4270	.....	0.4275
1,325	39,750	.4208	.4205	.4215	.4220	.4219	.....	.....	.....	0.4213
1,375	41,250	.4182	.4193	.4195	.4190	.4176	.....	.....	.....	0.4187
1,475	44,250	.4093	.4081	.4104	.4090	.4088	.4098	.....	.....	0.4092
1,575	47,250	.3998	.4003	.3989	.4008	.3996	.....	.....	.....	0.4001
1,675	50,250	.3920	.3913	.3908	.3912	.3929	.....	.....	.....	0.3914
1,775	53,250	.3830	.3842	.3829	.3831	.3834	.3828	.3831	.....	0.3832
1,875	56,200	.3740	3751	.3749	.3742	.3732	.....	.....	.....	0.3743
1,975	59,250	.3650	.3642	.3648	.3639	.3649	.3647	.....	.....	0.3648

Annealed coppers compressed at Watertown Arsenal.

[Original length, 0.5000 inch.]

Applied loads.	Corresponding pressure per square inch.	Length after compression.						
		No. 1.	No. 2.	No. 3.	No. 4.	No. 5.	No. 6.	Mean.
	Pounds.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
800	24,000	.4645	.4638	.4614	.4646	.....	.....	0.4643
1,000	30,000	.4497	.4499	.4499	.4490	.....	.....	0.4496
1,200	36,000	.4337	.4336	.4339	.4317	.4329	.4318	0.4329
1,400	42,000	.4168	.4164	.4168	.4170	.....	.....	0.4167
1,600	48,000	.3983	.3995	.3989	.3984	.....	.....	0.3988
1,800	54,000	.3823	.3815	.3811	.3809	.....	.....	0.3814

While some few anomalies are noticeable in the above results, yet generally exhibiting a fair uniformity as the loads were varied, they afford sufficient data from which a table of lengths corresponding to various pressures, from 20,000 to 60,000 pounds per square inch, can be constructed. Such a table appears below:

Table of pressures and corresponding lengths of copper.

Pressure per square inch.	Length of copper.	Pressure per square inch.	Length of copper.	Pressure per square inch.	Length of copper.	Pressure per square inch.	Length of copper.	Pressure per square inch.	Length of copper.
Pounds.	*Inch.*	*Pounds.*	*Inch.*	*Pounds.*	*Inch.*	*Pounds.*	*Inch.*	*Pounds.*	*Inch.*
20,000	0.4742	28,000	0.4544	32,000	0.4440	36,000	0.4332	40,000	0.4221
500	.4730	100	.4542	100	.4438	100	.4330	500	.4207
21,000	.4718	200	.4539	200	.4435	200	.4327	41,000	.4193
500	.4706	300	.4537	300	.4432	300	.4324	500	.4179
22,000	.4694	400	.4534	400	.4430	400	.4322	42,000	.4165
500	.4682	500	.4532	500	.4427	500	.4319	500	.4151
23,000	.4670	600	.4529	600	.4424	600	.4316	43,000	.4137
500	.4658	700	.4527	700	.4422	700	.4314	500	.4123
24,000	.4645	800	.4524	800	.4419	800	.4311	44,000	.4108
500	.4633	900	.4521	900	.4416	900	.4308	500	.4094
25,000	.4620	29,000	.4518	33,000	.4413	37,000	.4305	45,000	.4079
100	.4618	100	.4516	100	.4411	100	.4303	500	.4065
200	.4615	200	.4513	200	.4408	200	.4300	46,000	.4050
300	.4613	300	.4511	300	.4405	300	.4297	500	.4036
400	.4610	400	.4508	400	.4403	400	.4294	47,000	.4021
500	.4608	500	.4506	500	.4400	500	.4291	500	.4007
600	.4605	600	.4503	600	.4397	600	.4289	48,000	.3992
700	.4603	700	.4501	700	.4395	700	.4286	500	.3978
800	.4600	800	.4498	800	.4392	800	.4283	49,000	.3963
900	.4598	900	.4495	900	.4389	900	.4280	500	.3949
26,000	.4595	30,000	.4492	34,000	.4386	38,000	.4277	50,000	.3934
100	.4593	100	.4490	100	.4384	100	.4275	500	.3919
200	.4590	200	.4487	200	.4381	200	.4272	51,000	.3904
300	.4588	300	.4485	300	.4378	300	.4269	500	.3889
400	.4585	400	.4482	400	.4376	400	.4266	52,000	.3874
500	.4583	500	.4480	500	.4373	500	.4263	500	.3859
600	.4580	600	.4477	600	.4370	600	.4261	53,000	.3844
700	.4578	700	.4475	700	.4368	700	.4258	500	.3829
800	.4575	800	.4472	800	.4365	800	.4255	54,000	.3814
900	.4573	900	.4469	900	.4362	900	.4252	500	.3799
27,000	.4570	31,000	.4466	35,000	.4359	39,000	.4249	55,000	.3784
100	.4568	100	.4464	100	.4357	100	.4247	500	.3768
200	.4565	200	.4461	200	.4354	200	.4244	56,000	.3753
300	.4563	300	.4459	300	.4351	300	.4241	500	.3738
400	.4560	400	.4456	400	.4349	400	.4238	57,000	.3723
500	.4558	500	.4454	500	.4346	500	.4235	500	.3708
600	.4555	600	.4451	600	.4343	600	.4233	58,000	.3693
700	.4553	700	.4449	700	.4341	700	.4230	500	.3678
800	.4550	800	.4446	800	.4338	800	.4227	59,000	.3663
900	.4547	900	.4443	900	.4335	900	.4224	60,000	.3633

That the two methods of obtaining a record of the pressure of the powder gas might be fully compared, charges were fired of the service cartridge (70 grains black powder, 500-grain bullet) in the caliber .45 pressure barrel, and charges of 30, 32, 34, 35, 36, 37, and 38 grains of Wetteren smokeless powder with the 230-grain bullet in the caliber .30 pressure barrel.

With half the shots for each charge a record of the pressure was taken by means of the length of the cut, given by the cutter, and with the other half a record obtained from the length of the compressed copper cylinders.

In both the caliber .45 and the caliber .30 pressure barrels, and for the cutter, and also the crusher systems, the same piston (diameter .206 inch or $\frac{1}{30}$ square inch) was used, and all the remaining mechanism was similar, merely substituting for the circular knife and the block of copper a hard steel supporting piece and a copper cylinder to which a suitable initial compression had previously been given.

Omitting preliminary shots fired to determine the proper degree of initial compression, the results of the various charges are given in the following tables:

Caliber .45 pressure barrel.

[Charge: 70 grains black powder, 500-grain bullet.]

Shot.	Instrumental velocity.	Pressure indicated by cutter.	With crusher gauge.			
			Initial compression.	Corresponding length.	Length after firing.	Estimated pressure.
		Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Pounds.*
1	1,215	24,000	.....	.....	.....	.....
2	1,220	24,200	.....	.....	.....	.....
3	1,206	24,200	.....	.....	.....	.....
4	1,217	29,600	.....	.....	.....	.....
5	1,218	25,600	.....	.....	.....	.....
6	1,222	.....	18,750	0.4781	0.4681	22,500
7	1,223	.....	18,750	0.4765	0.4684	22,300
8	1,214	.....	20,250	0.4734	0.4683	22,400
9	1,215	.....	20,250	0.4751	0.4706	21,500
10	1,222	.....	20,250	0.4742	0.4667	23,100
11	1,209	.....	18,750	0.4771	0.4717	21,000
12	1,225	31,200	.....	.....	.....	.....
13	1,216	29,000	.....	.....	.....	.....
14	1,214	25,400	.....	.....	.....	.....
15	1,225	.....	18,750	0.4762	0.4711	21,300
16	1,220	.....	18,750	0.4796	0.4700	21,700
17	1,224	.....	21,750	0.4703	0.4652	23,700
18	1,215	.....	21,750	0.4699	0.4675	22,800
19	1,218	.....	23,250	0.4676	0.4657	23,500
20	1,222	.....	23,250	0.4652	0.4644	24,000
Mean	1,218	26,650	.....	.....	.....	22,483

Caliber .30 pressure barrel.

[Charge: 30 grains Wetteren powder, 230-grain bullet.]

Shot.	Instrumental velocity.	Pressure indicated by cutter.	With crusher gauge.			
			Initial compression.	Corresponding length.	Length after firing.	Estimated pressure.
		Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Pounds.*
1	1,553	32,800	.....	.....	.....	.....
2	1,545	30,400	.....	.....	.....	.....
3	1,538	31,400	.....	.....	.....	.....
4	1,534	.....	20,250	0.4733	0.4629	25,000
5	1,554	.....	20,250	0.4720	0.4604	25,700
6	1,541	.....	23,250	0.4668	0.4644	24,000
7	1,573	.....	23,250	0.4671	0.4611	25,400
8	1,559	.....	23,250	0.4658	0.4630	24,600
9	1,534	30,200	.....	.....	.....	.....
10	1,520	31,700	.....	.....	.....	.....
11	1,547	31,300	.....	.....	.....	.....
12	1,532	.....	20,250	0.4726	0.4619	25,000
13	1,554	.....	20,250	0.4732	0.4633	24,500
14	1,540	.....	20,250	0.4746	0.4610	25,400
15	1,524	29,600	.....	.....	.....	.....
16	1,562	33,000	.....	.....	.....	.....
17	1,538	.....	21,750	0.4680	0.4631	24,600
18	1,551	.....	21,750	0.4704	0.4615	25,200
19	1,549	30,000	.....	.....	.....	.....
20	1,558	32,600	.....	.....	.....	.....
Mean	1,544.3	31,300	.....	.....	.....	24,940

Caliber .30 pressure barrel.

[Charge: 32 grains Wetteren powder, 230-grain bullet.]

Shot.	Instrumental velocity.	Pressure indicated by cutter.	With crusher gauge.			
			Initial compression.	Corresponding length.	Length after firing.	Estimated pressure.
		Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Pounds.*
1	1,647	36,400	.....	.....	.....	.....
2	1,649	41,000	.....	.....	.....	.....
3	1,666	42,300	.....	.....	.....	.....
4	1,686	.....	26,250	0.4601	0.4532	28,500
5	1,654	.....	26,250	0.4605	0.4512	29,300
6	1,640	.....	26,250	0.4585	0.4543	28,100
7	1,630	.....	26,250	0.4607	0.4595	26,000
8	1,627	.....	26,250	0.4578	0.4567	27,100
9	1,666	36,000	.....	.....	.....	.....
10	1,660	36,200	.....	.....	.....	.....
11	1,652	38,000	.....	.....	.....	.....
12	1,690	40,100	.....	.....	.....	.....
13	1,683	.....	26,250	0.4576	0.4534	28,400
14	1,662	.....	26,250	0.4583	0.4569	27,000
15	1,691	.....	26,250	0.4570	0.4542	28,100
16	1,685	.....	21,750	0.4692	0.4535	28,400
17	1,659	.....	21,750	0.4687	0.4568	27,100
18	1,648	37,000	.....	.....	.....	.....
19	1,663	37,200	.....	.....	.....	.....
20	1,672	39,600	.....	.....	.....	.....
Mean	1,661.5	38,380	.....	.....	.....	27,800

Caliber .30 pressure barrel.

[Charge: 34 grains Wetteren powder, 230-grain bullet.]

Shot.	Instrumental velocity.	Pressure indicated by cutter.	With crusher gauge.			
			Initial compression.	Corresponding length.	Length after firing.	Estimated pressure.
		Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Pounds.*
1	1,771	43,600	.....	.....	.....	.....
2	1,785	47,100	.....	.....	.....	.....
3	1,734	44,000	.....	.....	.....	.....
4	1,779	.....	27,750	0.4559	0.4487	30,200
5	1,801	.....	27.750	0.4564	0.4424	32,600
6	1,785	.....	27,750	0.4550	0.4460	31,300
7	1,788	.....	29,250	0.4521	0.4464	31,100
8	1,769	45,300	.....	.....	.....	.....
9	1,782	48,000	.....	.....	.....	.....
10	1,787	47,100	.....	.....	.....	.....
11	1,762	45,000	.....	.....	.....	.....
12	1,759	.....	29,250	0.4526	0.4493	30,000
13	1,792	.....	29,250	0.4505	0.4419	32,800
14	1,785	.....	29,250	0.4514	0.4438	32,100
15	1,803	.....	29,250	0.4508	0.4410	33,100
16	1,786	.....	27,750	0.4543	0.4452	31,600
17	1,780	.....	27,750	0.4575	0.4459	31,300
18	1,771	44,800	.....	.....	.....	.....
19	1,795	48,200	.....	.....	.....	.....
20	1,793	45,900	.....	.....	.....	.....
Mean	1,780.3	45,900	.....	.....	.....	31,610

Caliber .30 pressure barrel.

[Charge: 35 grains Wetteren powder, 230-grain bullet.]

Shot.	Instrumental velocity.	Pressure indicated by cutter.	With crusher gauge.			
			Initial compression.	Corresponding length.	Length after firing.	Estimated pressure.
		Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Pounds.*
1	1,886	51,200	.....	.....	.....	.....
2	1,851	47,400	.....	.....	.....	.....
3	1,885	51,600	.....	.....	.....	.....
4	1,872	.....	29,250	0.4518	0.4381	34,200
5	1,848	.....	29,250	0.4508	0.4396	33,600
6	1,805	.....	30,750	0.4478	0.4419	32,800
7	1,871	.....	30,750	0.4462	0.4330	36,100
8	1,838	.....	30,750	0.4463	0.4385	34,000
9	1,837	51,600	.....	.....	.....	.....
10	1,860	54,800	.....	.....	.....	.....
11	1,848	.....	32,250	0.4441	0.4371	34,600
12	1,906	.....	32,250	0.4432	0.4304	37,000
13	1,846	.....	32,250	0.4426	0.4373	34,500
14	1,872	49,000	.....	.....	.....	.....
15	1,906	51,700	.....	.....	.....	.....
16	1,893	.....	30,750	0.4486	0.4391	33,800
17	1,865	.....	30,750	0.4493	0.4441	32,000
18	1,893	50,300	.....	.....	.....	.....
19	1,880	49,600	.....	.....	.....	.....
20	1,895	54,200	.....	.....	.....	.....
Mean	1,867.8	51,140	.....	.....	.....	34,260

Caliber .30 pressure barrel.

[Charge: 36 grains Wetteren powder, 230-grain bullet.]

Shot.	Instrumental velocity.	Pressure indicated by cutter.	With crusher gauge.			
			Initial compression.	Corresponding length.	Length after firing.	Estimated pressure.
		Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Pounds.*
1	1,891	54,800	.....	.....	.....	.....
2	1,907	57,500	.....	.....	.....	.....
3	1,916	.....	32,250	0.4461	0.4283	37,800
4	1,907	.....	32,250	0.4458	0.4346	35,500
5	1,895	55,200	.....	.....	.....	.....
6	1,899	57,700	.....	.....	.....	.....
7	1,912	.....	33,750	0.4403	0.4262	38,500
8	1,886	.....	33,750	0.4412	0.4370	34,600
9	1,946	.....	33,750	0.4403	0.4264	38,500
10	1,885	.....	33,750	0.4398	0.4353	35,200
11	1,890	55,200	.....	.....	.....	.....
12	1,912	52,200	.....	.....	.....	.....
13	1,940	.....	33,750	0.4385	0.4266	38,400
14	1,928	58,400	.....	.....	.....	.....
15	1,924	57,000	.....	.....	.....	.....
16	1,918	.....	33,750	0.4388	0.4311	36,800
17	1,875	51,300	.....	.....	.....	.....
18	1,878	.....	33,750	0.4380	0.4333	36,000
19	1,898	.....	33,750	0.4379	0.4304	37,100
20	1,894	54,200	.....	.....	.....	.....
Mean	1,905	55,350	.....	.....	.....	36,640

Caliber .30 pressure barrel.

[Charge: 37 grains Wetteren powder, 230-grain bullet.]

Shot.	Instrumental velocity.	Pressure indicated by cutter.	With crusher gauge.			
			Initial compression.	Corresponding lengths.	Length after firing.	Estimated pressure.
		Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Pounds.*
1	1,969	61,000	.....	.....	.....	.....
2	1,965	57,200	.....	.....	.....	.....
3	1,955	.....	35,250	0.4340	0.4249	39,000
4	1,967	.....	35,250	0.4339	0.4266	38,400
5	1,957	.....	35,250	0.4364	0.4245	39,200
6	1,973	.....	35,250	0.4341	0.4238	39,400
7	1,947	.....	35,250	0.4350	0.5270	38,300
8	1,957	56,500	.....	.....	.....	.....
9	1,959	61,100	.....	.....	.....	.....
10	1,945	58,200	.....	.....	.....	.....
11	1,963	57,300	.....	.....	.....	.....
12	1,971	60,400	.....	.....	.....	.....
13	1,949	.....	35,250	0.4335	0.4272	38,200
14	1,954	.....	35,250	0.4340	0.4264	38,500
15	1,960	.....	36,750	0.4321	0.4260	38,600
16	1,968	60,300	.....	.....	.....	.....
17	1,952	59,000	.....	.....	.....	.....
18	1,955	57,800	.....	.....	.....	.....
19	1,958	.....	36,750	0.4330	0.4269	38,300
20	1,961	.....	36,750	0.4318	0.4250	39,000
Mean	1,959.3	58,880	.....	.....	.....	38,690

Caliber .30 pressure barrel.

[Charge: 38 grains Wetteren powder, 230-grain bullet.]

Shot.	Instrumental velocity.	Pressure indicated by cutter.	With crusher gauge.			
			Initial compression.	Corresponding length.	Length after firing.	Estimated pressure.
		Pounds.	*Pounds.*	*Inch.*	*Inch.*	*Pounds.*
1	1,969	58,800	.....	.....	.....	.....
2	1,989	60,800	.....	.....	.....	.....
3	1,993	63,800	.....	.....	.....	.....
4	1,959	.....	36,750	0.4324	0.4238	39,400
5	1,981	.....	36,750	0.4326	0.4237	39,400
6	1,997	.....	36,750	0.4306	0.4185	41,300
7	1,981	.....	38,250	0.4264	0.4200	40,700
8	1,999	.....	38,250	0.4258	0.4182	41,400
9	1,967	63,400	.....	.....	.....	.....
10	1,995	60,700	.....	.....	.....	.....
11	1,980	62,000	.....	.....	.....	.....
12	1,975	59,800	.....	.....	.....	.....
13	1,996	.....	38,250	0.4281	0.4194	41,000
14	1,990	.....	38,250	0.4279	0.4198	40,800
15	1,974	.....	38,250	0.4286	0.4250	39,000
16	1,978	.....	38,250	0.4284	0.4247	39,100
17	1,986	.....	38,250	0.4270	0.4190	41,100
18	1,990	63,000	.....	.....	.....	.....
19	1,986	58,600	.....	.....	.....	.....
20	1,985	61,500	.....	.....	.....	.....
Mean	1,983.5	61,240	.....	.....	.....	40,320

Summary of velocities and pressures.

Charges.	Caliber of barrel.	Instrumental velocity.	Pressure indicated by—		Crusher. Per cent of cutter.
			Cutter.	Crusher.	
			Pounds.	*Pounds.*	*Pounds.*
70 grains black powder	.45	1,218	26,650	22,483	.844
30 grains Wetteren	.30	1,544.3	31,300	24,940	.797
32 grains Wetteren	.30	1,661.5	38,380	27,800	.724
34 grains Wetteren	.30	1,780.3	45,900	31,610	.689
35 grains Wetteren	.30	1,867.8	51,140	34,260	.670
36 grains Wetteren	.30	1,905	55,350	36,640	.662
37 grains Wetteren	.30	1,959.3	58,880	38,690	.657
38 grains Wetteren	.30	1,983.5	61,240	40,320	.658

An examination of the preceding tables shows that for all pressures the indications given by the cutter are in excess of those found when the crusher system is employed, and while for low velocities this difference is not very great, that it steadily increases as the charge and consequent pressure is augmented.

For reasons given earlier in this report it is believed the crusher method, with coppers to which an initial compression has been given, affords more reliable results than those obtained with the cutter, and it is therefore recommended that such method be followed in the future.

While the pressures reported from this armory for many years past, certainly with charges of smokeless powders, are probably in excess of those actually occurring in the chamber of the small arm, there is yet no necessity of rejecting entirely the results obtained, since by applying the proper multiplier to the pressure indicated by the cutter it can at once be converted into what would probably have been the crusher record.

Using the appropriate multipliers for the different pressures deduced from the relations between the cutter and crusher indications exhibited in the preceding summary, a table for passing, with considerable accuracy, from one to the other of the methods, may be constructed as follows:

Table for reducing cutter to crusher indicated pressure.

Pressure indicated by cutter.	True or crusher pressure.	Pressure indicated by cutter.	True or crusher pressure.	Pressure indicated by cutter.	True or crusher pressure.	Pressure indicated by cutter.	True or crusher pressure.
Pounds.	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*	*Pounds.*
25,000	21,250	34,000	26,110	43,000	30,190	52,000	34,630
26,000	21,840	35,000	26,600	44,000	30,640	53,000	35,190
27,000	22,410	36,000	27,070	45,000	31,100	54,000	35,750
28,000	22,960	37,000	27,530	46,000	31,560	55,000	36,300
29,000	23,490	38,000	27,970	47,000	32,050	56,000	36,850
30,000	24,020	39,000	28,410	48,000	32,540	57,000	37,390
31,000	24,550	40,000	28,850	49,000	33,050	58,000	37,930
32,000	25,080	41,000	29,290	50,000	33,560	59,000	38,470
33,000	25,600	42,000	29,740	51,000	34,080	60,000	39,000

In the tests of smokeless powders made at this armory during the last two years the highest charges considered allowable have been such as gave pressures, as indicated with the cutter, of 55,000 or 60,000 pounds per square inch, or actual pressures, it would now appear, of 36,000 or 39,000 pounds, and the Board on Magazine Arms is now using cartridges producing pressures between these limits.

Very respectfully, your obedient servant,

S. E. BLUNT,
Captain, Ord. Dept., U. S. Army.

Col. A. MORDECAI,
Commanding.
(2370–'92.)

SPRINGFIELD ARMORY, MASS., *April 22, 1892.*

SIR: In accordance with your verbal directions, I have the honor to make the following report of certain trials with the cutter and crusher pressure gauges, supplementary to my report of March 31, 1892, upon the same subject:

The object of this later test was to determine the effect of initial cuts or compressions produced by different loads applied to the copper before firing.

After applying the load the cut was measured, the knife carefully replaced therein, and the copper then used to determine the pressure in the gun.

Results obtained with cutter gauge.

[Charge, 36 grains Wetteren.]

Shot.	Instrumental velocity.	Initial load per square inch.	Length of cut.		Pressure.
			Initial.	After firing.	
		Pounds.	*Inch.*	*Inch.*	*Pounds.*
1	1,890	.....	.....	0.690	54,200
2	1,920	.....	.....	0.706	57,400
3	1,878	.....	.....	0.699	56,000
4	1,916	.....	.....	0.686	53,200
5	1,922	.....	.....	0.698	55,600
6	1,887	.....	.....	0.693	54,800
7	1,932	53,250	0.684	0.696	55,400
8	1,899	53,250	0.680	0.692	54,600
9	1,898	53,250	0.685	0.687	53,600
10	1,910	50,250	0.670	0.688	53,800
11	1,874	50,250	0.671	0.694	55,000
12	1,883	47,250	0.652	0.684	53,000
13	1,901	47,250	0.656	0.679	52,000
14	1,904	33,750	0.580	0.688	53,800
15	1,898	33,750	0.578	0.657	47,800
16	1,924	33,750	0.582	0.659	48,200
17	1,912	33,750	0.584	0.648	46,200
18	1,922	33,750	0.580	0.669	50,200
19	1,906	33,750	0.579	0.675	51,200
20	1,899	33,750	0.581	0.672	50,600

The mean instrumental velocity for the twenty shots was 1,903.75 feet.

The mean pressure when no initial cut was given was 55,200 pounds. As loads less than this amount per square inch were applied, the length of cut and the indicated pressure after firing decreased, but not so rapidly as the decrease in the load, a mean pressure of 49,710 pounds being indicated after an initial load of 33,750 pounds per square inch had been given.

This load of 33,750 pounds was selected because it had been applied, with most of the shots fired with this charge, to the coppers used in the crusher gauge as stated in my report of March 31. With that gauge a mean pressure, after firing, of 36,640 pounds was obtained.

It will be observed that while giving an initial cut results in a lower final record than when the cutter gauge is used without it, yet that the indicated pressure is greatly in excess of that shown by the crusher gauge using cylinders first subjected to an initial load, and also in excess of what is believed to really exist.

To more fully determine the effect of the initial load when using the crusher gauge, charges of 36 grains of Wetteren powder were fired and the pressure taken with copper cylinders to which no initial compression had been given, with coppers to which a load much less than the anticipated pressure had been applied, and with coppers subjected to a pressure greater than that expected.

Results obtained with crusher gauge.

[Charge, 36 grains Wetteren.]

Shot.	Instrumental velocity.	Initial load per square inch.	Length of copper.		Indicated pressure.
			After application of load.	After firing.	
	Feet.	*Pounds.*	*Inch.*	*Inch.*	*Pounds.*
1	1,890	None.	0.5000	0.3881	51,800
2	1,899	None.	0.5000	0.3865	52,300
3	1,908	None.	0.4999	0.3870	52,100
4	1,899	None.	0.4999	0.3864	52,300
5	1,902	None.	0.5000	0.3842	53,000
6	1,890	None.	0.5000	0.3880	51,800
7	1,895	20,250	0.4740	0.4055	45,800
8	1,912	20,250	0.4734	0.4025	46,900
9	1,890	20,250	0.4752	0.4084	44,800
10	1,925	20,250	0.4748	0.4018	47,100
11	1,902	20,250	0.4730	0.4062	45,600
12	1,918	20,250	0.4732	0.4051	46,000
13	1,912	39,750	0.4228	0.4204	40,600
14	1,908	39,750	0.4220	0.4201	40,700
15	1,910	39,750	0.4231	0.4212	40,300
16	1,914	39,750	0.4225	0.4209	40,400
17	1,916	42,750	0.4139	0.4138	43,000
18	1,908	42,750	0.4143	0.4140	42,900
19	1,920	42,750	0.4140	0.4136	43,000
20	1,910	42,750	0.4142	0.4140	42,900

The mean instrumental velocity for the twenty shots was 1,906.4 feet.

For this charge and velocity my report of March 31 shows that after an initial load per square inch of 33,750 pounds was applied an average pressure of 36,640 pounds was indicated.

In the present case when no initial compression was applied to the coppers a mean pressure after firing of 52,200 pounds was indicated, and when a load of 20,250 pounds per square inch had been applied a pressure after firing of 46,000 pounds was shown. When an initial

pressure somewhat greater than expected was given, the coppers upon firing were still further compressed; about 0.002 inch when the pressure was increased about 3,000 pounds over that expected and about 0.0002 inch when the increase was 6,000 pounds.

Considering these, as well as the previous trials, a superiority of the crusher over the cutter method of obtaining a record of the pressures appears evident; also that an initial load about 2,000 to 4,000 pounds per square inch less than the pressure expected should first be applied. If given with the crusher a slight further compression (about 0.006 or 0.012 inch) of the copper follows on firing. If given with the cutter, unless a much greater load than for the crusher be first applied, a considerable increase in the length of cut upon firing will be observed, and not until the applied load nearly approaches the pressure indicated by the cutter, when used without initial cut, will the increase in length of the cut after firing be but slight.

Very respectfully, your obedient servant,

S. E. BLUNT,
Captain, Ord. Dept., U. S. Army.

Col. A. MORDECAI,
Commanding.
(2370–'92.)

SPRINGFIELD ARMORY,
Springfield, Mass., April 14, 1892.

SIR: In accordance with your verbal directions, I have the honor to submit the following description and rules for using the Springfield Armory pressure gauge, as adapted for obtaining pressures by either the cutter or crusher methods.

DESCRIPTION.

The pressure guage consists of a barrel chambered for the caliber .30 cartridge as made at Frankford Arsenal for the use of the Board on Magazine Arms, with a housing which embraces the chamber and affords support for the apparatus registering the pressure.

Vertically through the housing and chamber (perpendicular to the axis of the bore) is a channel for the piston; above that the housing forks (Figs. 1 and 2), the arms later uniting in a bar, tapped for the screw E.

The piston (*p*) is, on its lower face, where exposed to the powder gas, 0.206 of an inch in diameter, giving its cross section, therefore, an area of one-thirtieth of a square inch. It is straight, with seven cannelures, and its upper portion is enlarged, forming a shoulder (A), which abuts against the metal around the upper end of the channel in the housing. This piston head is pierced for a steel rod, by which its removal from the housing is facilitated.

In that portion of the cartridge case which when in the chamber lies directly below the piston channel a circular hole is cut very slightly larger than the piston. Before the shell is loaded this hole is closed by introducing through the mouth of the cartridge a thin piece of tissue spring brass (1.1 inches by 0.68 inch by 0.003 inch thick), which, on discharge, serves as a gas check. A notch (*f*) on the face of the counterbore of the barrel and another on the head of the cartridge indicate the proper position for the cartridge in the chamber.

The apparatus can be used with either the Rodman cutter and a block of copper, the pressure being deduced from the length of the cut made in the latter, or with an adjusting steel sleeve and a small cylinder of copper when the pressure can be deduced from the compression given the cylinder.

From rather extended trials made during the past few months, and reported upon by me under date of March 31, 1892, it was concluded that the latter method was the more reliable.

With either method cartridges pierced with the hole above mentioned and with the brass gas check are used. The bullet should not be pushed down upon the powder unless the latter fills the shell, but so introduced into the neck that the last cannelure will be entirely covered. The proper length of the loaded cartridge is 3.09 inches.

Pressures by the cutter (Fig. 1).

Slightly oil the piston and seat it in the housing, the shoulder (*a*) well pushed down; place the knife (*b*, Figs. 1 and 3) cutting edge up, upon the piston, the recess in the former (*r*, Fig. 3) embracing the enlarged head (*h*, Fig. 1) of the latter; lay the copper block (*c*, Figs. 1 and 3), with its largest surfaces horizontal, upon the knife; upon the copper place the steel block (*d*, Figs. 1 and 3 and in plan view, *n*, Fig. 3); turn down the screw (*e*, Fig. 1) until all is secure, but with not sufficient force to more than very slightly indent the copper. Introduce the loaded cartridge into the chamber, adjusting its position by means of the notches (*f*). After firing retract the screw (*e*) and carefully remove the copper; take off, in a pair of dividers, the length of the cut, and measure this length on an appropriate scale. With this length enter a table previously constructed (by means of the Benton dynamometer) for the coppers in use, which, with the length of cut as an argument, gives the corresponding pressure per square inch of the powder gas. The coppers in use at the Springfield Armory are rectangular parallelopipedons with edges of 1.213 inches, 0.696 inch, and 0.427 inch. They are cut from carefully annealed bars of rolled copper. With these coppers and the cutter the following table is used:

Table of pressures for cutter.

Length of cut.	Powder pressure.	Length of cut.	Powder pressure.	Length of cut.	Powder pressure.	Length of cut.	Powder pressure.
Inch.	*Pounds.*	*Inch.*	*Pounds.*	*Inch.*	*Pounds.*	*Inch.*	*Pounds.*
.498	20,000	.587	35,000	.668	50,000	.742	65,000
.504	21,000	.593	36,000	.674	51,000	.747	66,000
.510	22,000	.599	37,000	.679	52,000	.752	67,000
.516	23,000	.604	38,000	.684	53,000	.756	68,000
.522	24,000	.610	39,000	.689	54,000	.761	69,000
.528	25,000	.615	40,000	.694	55,000	.766	70,000
.534	26,000	.620	41,000	.699	56,000	.770	71,000
.540	27,000	.626	42,000	.704	57,000	.775	72,000
.546	28,000	.631	43,000	.709	58,000	.780	73,000
.552	29,000	.636	44,000	.714	59,000	.784	74,000
.558	30,000	.642	45,000	.719	60,000	.789	75,000
.564	31,000	.647	46,000	.724	61,000	.793	76,000
.570	32,000	.652	47,000	.728	62,000	.797	77,000
.576	33,000	.658	48,000	.733	63,000	.802	78,000
.582	34,000	.663	49,000	.738	64,000	.806	79,000

Pressures by crusher (Fig. 2).

Slightly oil the piston and seat it in the housing, the shoulder (*a*) well pushed down; place the sleeve (*b*, Figs. 2 and 4) upon the piston, the recess of the former (*r*, Fig. 4) embracing the enlarged head of the

latter; lay the copper cylinder (*c*, Figs. 2 and 4) with its axis vertical upon the flat top of the sleeve. To this copper cylinder a compressing load, corresponding to a pressure per square inch about 2,000 to 4,000 pounds less than that anticipated in the chamber, should first have been applied in the direction of its axis. Upon the copper place the steel block (*a*, Figs. 2 and 4, and in plan view, *n*, Fig. 4) or it will be found easier to hold the block up against the lower face of the screw (*e*). Turn down the screw (*e*, Fig. 2) until all is secure, care being exercised that the axis of the copper cylinder is approximately the prolongation of that of the piston. Introduce, as with the cutter system, the loaded cartridge.

After firing, measure the length of the cylinder with suitable micrometer calipers. With this length enter a table, previously constructed for the coppers in use, giving opposite the length of the compressed cylinder the corresponding pressure per square inch.

The copper cylinders used at the armory are, before initial compression, right cylinders, with circular bases, having a diameter of 0.206 of an inch (area, $\frac{1}{30}$ square inch); their altitude is one-half an inch. They are made from the same rolled bars as the blocks used in the cutter method, and after fabrication are carefully annealed. With these coppers the pressure per square inch, producing various lengths, is given in the table on pages 10 and 11 of my report of March 31, 1892, previously mentioned. For convenience of reference that table is now repeated, as below:

Table of pressures and corresponding lengths of copper cylinders.

Pressure per square inch.	Length of copper.	Pressure per square inch.	Length of copper.	Pressure per square inch.	Length of copper.	Pressure per square inch.	Length of copper.	Pressure per square inch.	Length of copper.
Pounds.	*Inch.*	*Pounds.*	*Inch.*	*Pounds.*	*Inch.*	*Pounds.*	*Inch.*	*Pounds.*	*Inch.*
20,000	.4742	28,000	.4544	32,000	.4440	36,000	.4332	40,000	.4221
500	.4730	100	.4542	100	.4438	100	.4330	500	.4207
21,000	.4718	200	.4539	200	.4435	200	.4327	41,000	.4193
500	.4706	300	.4537	300	.4432	300	.4324	500	.4179
22,000	.4694	400	.4534	400	.4430	400	.4322	42,000	.4165
500	.4682	500	.4532	500	.4427	500	.4319	500	.4151
23,000	.4670	600	.4529	600	.4424	600	.4316	43,000	.4137
500	.4658	700	.4527	700	.4422	700	.4314	500	.4123
24,000	.4645	800	.4524	800	.4419	800	.4311	44,000	.4108
500	.4633	900	.4521	900	.4416	900	.4308	500	.4094
25,000	.4620	29,000	.4518	33,000	.4413	37,000	.4305	45,000	.4079
100	.4618	100	.4516	100	.4411	100	.4303	500	.4065
200	.4615	200	.4513	200	.4408	200	.4300	46,000	.4050
300	.4613	300	.4511	300	.4405	300	.4297	500	.4036
400	.4610	400	.4508	400	.4403	400	.4294	47,000	.4021
500	.4608	500	.4506	500	.4400	500	.4291	500	.4007
600	.4605	600	.4503	600	.4397	600	.4289	48,000	.3992
700	.4603	700	.4501	700	.4395	700	.4286	500	.3978
800	.4600	800	.4498	800	.4392	800	.4283	49,000	.3963
900	.4598	900	.4495	900	.4389	900	.4280	500	.3949
26,000	.4595	30,000	.4492	34,000	.4386	38,000	.4277	50,000	.3934
100	.4593	100	.4490	100	.4384	100	.4275	500	.3919
200	.4590	200	.4487	200	.4381	200	.4272	51,000	.3904
300	.4588	300	.4485	300	.4378	300	.4269	500	.3889
400	.4585	400	.4482	400	.4376	400	.4266	52,000	.3874
500	.4583	500	.4480	500	.4373	500	.4263	500	.3859
600	.4580	600	.4477	600	.4370	600	.4261	53,000	.3844
700	.4578	700	.4475	700	.4368	700	.4258	500	.3829
800	.4575	800	.4472	800	.4365	800	.4255	54,000	.3814
900	.4573	900	.4469	900	.4362	900	.4252	500	.3799
27,000	.4570	31,000	.4466	35,000	.4359	39,000	.4249	55,000	.3784
100	.4568	100	.4464	100	.4357	100	.4247	500	.3768
200	.4565	200	.4461	200	.4354	200	.4244	56,000	.3753
300	.4563	300	.4459	300	.4351	300	.4241	500	.3738
400	.4560	400	.4456	400	.4349	400	.4238	57,000	.3723
500	.4558	500	.4454	500	.4346	500	.4235	500	.3708
600	.4555	600	.4451	600	.4343	600	.4233	58,000	.3693
700	.4553	700	.4449	700	.4341	700	.4230	500	.3678
800	.4550	800	.4446	800	.4338	800	.4227	59,000	.3663
900	.4547	900	.4443	900	.4335	900	.4224	60,000	.3633

The initial load can be applied to the coppers immediately before using, or various loads can be applied some time in advance and the cylinders put aside until needed for obtaining pressures. The initial load is given by the Benton dynamometer, the compression being continued only long enough to bring the dynamometer spring to the proper length.

The use of the cutter indicates pressures considerably in excess of those shown when the crusher method is employed. The relations between the two indications are given in tabular form on page 22 of the report already mentioned, to which attention is invited.

Very respectfully, your obedient servant,

S. E. BLUNT,
Captain, Ord. Dept., U. S. Army.

Col. A. MORDECAI,
Commanding.
(2370–'92.)

FRANKFORD ARSENAL,
Philadelphia, Pa., August 31, 1892.

SIR: I have the honor to report the following results (see table) regarding pressures obtained with the wall-pressure rifle, caliber .30, using 36 grains Wetteren powder with the copper-covered (230 grains) bullet. A table of compression made for the copper cylinders at Watertown Arsenal has been used on which to base the calculations, as the data obtained by the lever dynamometer at the Frankford Arsenal gave very high and irregular results. The diameter of the cylinders used was .251 inch, having an area of 1.48 times that of those used by Capt. Blunt in his report (April 22, 1892).

The initial pressure given to the cylinders before firing was 30,000 pounds per square inch of piston surface. The length of the cylinders was the same in both cases. I obtained with one set of cylinders an average pressure of 49,400 pounds, and with a softer set 44,886 pounds, against about 40,500 with an initial pressure of 39,750 pounds in Capt. Blunt's case. The slight differences may be due to the smaller area of cylinders used and to different initial pressures.

Caliber .30 wall pressure barrel.

JUNE 2, 1892.

[Charge: 36 grains Wetteren powder, 230 grains copper-covered bullet; with crusher 0.5 by 0.251 inch; cylinders.]

Shot.	Instrumental velocity.	Initial compression per square inch.	Corresponding length.	Length after fire.	Estimated pressure per square inch.
		Pounds.	*Inch.*	*Inch.*	*Pounds.*
1	1,930	30,000	.4862	.4406	52,200
2	1,880	30,000	.4869	.4493	48,600
3	1,898	30,000	.4866	.4530	45,000
4	1,894	30,000	.4865	.4483	47,400
5	1,886	30,000	.4865	.4430	51,000
6	1,890	30,000	.4863	.4460	49,500
7	1,871	30,000	.4863	.4483	45,900
8	1,880	30,000	.4863	.4453	49,800
9	Lost.	30,000	.4868	.4412	52,200
10	1,886	30,000	.4863	.4394	52,500
Mean	1,890.5	.....	.4864	.4454	49,410

The coppers used are known as the 100-pound lot. Area of piston, $\frac{1}{30}$ inch.

Caliber .30 wall pressure barrel—Continued.

JUNE 29, 1892.

[Charge: 36 grains Wetteren powder, 230 grains copper-covered bullet; with crusher 0.5 by 0.251 inch; cylinders.]

1	1,885	30,000	.4812	.4592	44,010
2	1,880	30,000	.4814	.4568	45,480
3	Lost.	30,000	.4806	.4636	41,220
4	1,801	30,000	.4812	.4591	43,950
5	1,835	30,000	.4801	.4505	49,770
Mean	1,850.2		.4809	.4578	44,886

Coppers, 100-pound lot, annealed June 27, 1892.
Table made at Watertown Arsenal August 17, 1892.

Very respectfully, your obedient servant,

J. PITMAN,
Captain, Ordnance Department.

The COMMANDING OFFICER FRANKFORD ARSENAL.
(2370–'92.)

SPRINGFIELD ARMORY, MASS.,
September 9, 1892.

SIR: In accordance with your directions of the 5th instant, I have the honor to report as follows upon the tests formerly made at this armory and lately at Frankford Arsenal (report of Capt. John Pitman, Ordnance Department, dated August 31, 1892), to determine the pressure in the chamber of the caliber 0.30 inch pressure barrel.

A comparison of the tests conducted by Capt. Pitman with those made here and reported upon under dates of March 31 and April 22, 1892, shows the following principal points of difference:

At the armory (1) the area of the cross section of the copper cylinders was $\frac{1}{30}$ square inch. (2) The initial load applied was from 2,000 to 6,000 (generally not more than 3,000) pounds per square inch less than the anticipated (and resulting) pressure. (3) The further compression given the cylinders by firing was in the majority of cases less than 0.010 inch, the average for the eighty-two shots given in the report of March 31 being less than 0.008 inch.

At Frankford Arsenal (1) the area of the cross section of the cylinders was nearly $\frac{1}{20}$ square inch. (2) The initial load applied was from 11,000 to 22,000 pounds less than the realized pressure. (3) Consequently the further shortening of the cylinders upon firing was considerable, the average for one group of ten shots being 0.041 inch and for another group of five shots 0.023 inch.

It is not thought that the slight difference in area of the coppers sufficiently accounts for the different results obtained here and at Frankford; it is rather believed that they should be credited to the different initial pressures given. In both reports, especially in that of April 22, 1892, the necessity is mentioned of applying initial loads nearly (from 2,000 to 4,000 pounds per square inch) up to the pressure recorded upon firing, or, in other words, of giving such initial compression that upon firing the cylinders shall not be further shortened more than (on an average) about 0.010 inch.

The second sets of trials reported upon, under date of April 22, were undertaken in accordance with your directions to observe the effect of

giving a less initial load or of producing on discharge an increased amount of shortening of the cylinder, that is, of permitting to the piston a greater motion. An examination of the last table in the report shows that instead of a record of 36,640 pounds, obtained after an initial load of 33,750 had been applied, that when no load was given a record of 52,200 pounds was found, and when the load was 20,250 a record of 46,000 pounds was shown.

But these results were not considered correct representations of the actual pressure, dependence being rather placed upon a record exceeding by less than 10 per cent the amount of initial load and indicated by a piston whose motion had been slight.

At Frankford the record (for the fifteen shots) exceeds by nearly 60 per cent the initial load or brings the tests more in the same category as the second set of trials held here and renders them not fairly comparable with the first set from which the actual pressures were inferred.

For these reasons I am constrained to adhere to my formerly expressed belief that the pressure with 36 grains of Wetteren powder in the caliber 0.30 inch pressure barrel is below, rather than over, 40,000 pounds.

Very respectfully, your obedient servant,

S. E. BLUNT,
Captain, Ord. Dept., U. S. Army.

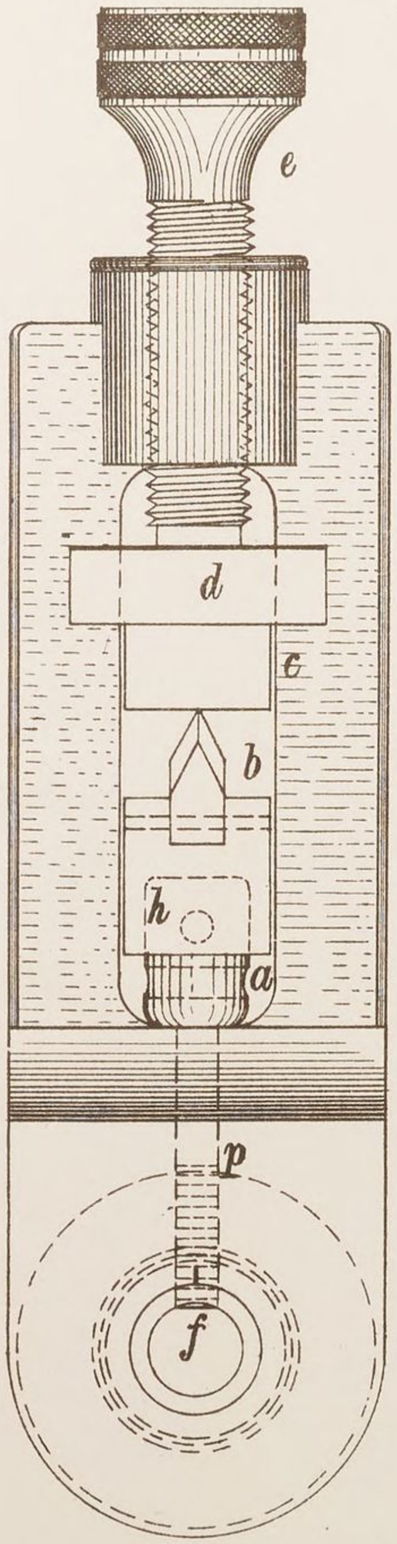
The COMMANDING OFFICER SPRINGFIELD ARMORY.

(2370–'92.)

Springfield Armory Pressure Gauge.

For Small Arms.

Fig.1.



Used as cutter gauge.

Fig.3.

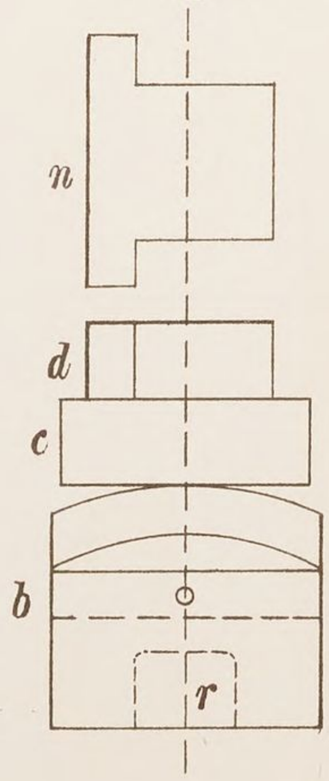
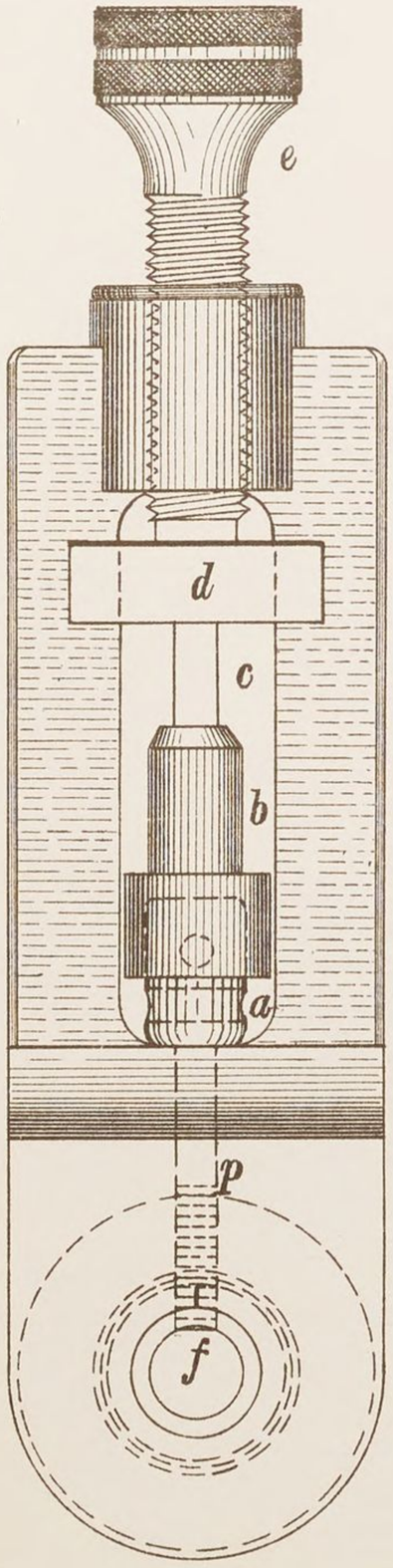
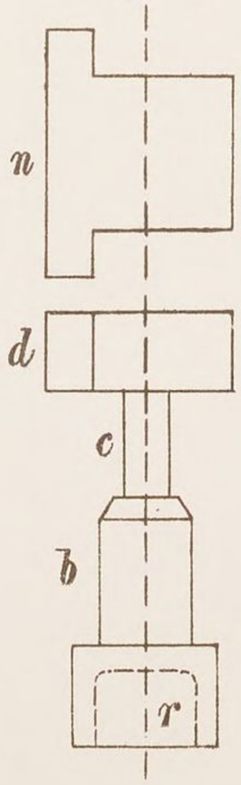


Fig.2.



Used as crusher gauge.

Fig.4.



2370-'92, Enc. 3.

Appendix 45, 1892.

APPENDIX 46.

THE FRANKFORD ARSENAL 3.2-INCH SHRAPNEL; DESCRIPTION AND REPORT OF FIRING TEST.

(6 plates.)

DESCRIPTION OF THE FRANKFORD ARSENAL SHRAPNEL FOR 3.2-INCH B. L. RIFLE.

The shrapnel, exclusive of filling, consists of three parts, viz, head, body, and base.

The head.

(See Fig. I*a*.)

This is made of cast iron, machined on the exterior, and has a screw thread cut around its base, fitting into the forward part of the body. It is bored and threaded to receive the Frankford Arsenal combination fuse. The head contains the powder chamber, which has a capacity of $2\frac{3}{4}$ ounces. Its interior surface is lacquered to prevent danger of premature ignition from friction.

The body.

(Fig. I*b*.)

This is made of lap-welded wrought-iron or low-steel tubing, machined on the exterior and interior to dimensions, and is threaded front and rear to receive the head and base. It is weakened, for fracture, by circular and longitudinal grooves cut on the inside. It contains a charge of 162 balls, 41+ to the pound, 0.5 inch in diameter, made from an alloy of $8\frac{1}{2}$ parts lead and 1 part antimony. These are assembled in the case in circular layers, and held symmetrically in position by cast-iron separators, so called, made as shown in Figs. 4, 5, 6, and 7.

The separators are intended to prevent excessive lodgment or deformation of the balls under the shock of discharge and increase the effect of explosion by furnishing additional fragments of effective weight. A separator, Fig. 7, is placed at the bottom, fitting by means of lugs into recesses in the base, by which independent rotation of the charge of balls is prevented. Two full rings, Figs. 1 *f* and *h* and 5 *f* and 6 *h*, are placed in the middle of the charge for strength. A separator, flat on the upper side, is placed on top of the charge of balls, and against it the head is screwed.

The base.

(Fig. Ic.)

The base is of cast iron, threaded to screw into the cylindrical case. It is so made as to form a support to the copper band to prevent deformation of the case at this point from the shock of discharge. The band is of copper, shrunk on its seat and forced into place by running through a die. The seat is roughened to prevent slipping of the band. The total weight of the shrapnel, exclusive of fuse, is 12 pounds 6.5 ounces. The total number of balls and individual pieces in a shrapnel, complete, is 201.

Table of maximum and minimum weights and dimensions.

Weights and dimensions.		Maximum.	Minimum.
Weight (without fuse or bursting charge)	pounds	12	12
	ounces	6.5	4.5
Total length (without fuse)	inches	7.5	7.4
Length of head (without fuse)	do	2.875	.....
Diameter of body	do	3.185	3.17
Diameter of head at front	do	1.96	.....
Radius of head, inside	do	3.	.....
Thickness of base	do	0.5	.....
Thickness of separators	do	0.49	.....
Thickness of top plate	do	.25	.....
Thickness of bottom plate	do	0.50	.....
Thickness of walls:			
Powder chamber	do	0.375	.....
Body	do	0.205	0.2
Length of powder chamber	do	1.915	.....
Length of ball chamber	do	4	.....
Depth of fuse seat to end of thread	do	1.23	.....
Diameter of fuse seat within threads	do	1.00	.....
Number of threads per inch	number	8	.....
Exterior diameter of band	inches	3.30	.....
Width of band	do	0.5	.....
Distance of band from base	do	0.625	.....
Diameter of ball	do	0.5	.....
Weight of ball (41+ to the pound)	grains	171	.....
Number of balls	number	162	.....
Weight of fuse	pounds	1	.....
	ounces	¾	.....
Weight of powder charge	do	2¾	.....
Weight, total, of shrapnel	pounds	13	13
	ounces	10	8

Respectfully submitted.

FRANK BAKER,
Captain of Ordnance, in Charge of Shops.

Respectfully forwarded to the Chief of Ordnance, U. S. Army, in compliance with instructions of September 13, 1892. Drawing of shrapnel inclosed herewith.

J. P. FARLEY,
Lieutenant-Colonel of Ordnance, Commanding.

REPORT OF FIRING TESTS, SANDY HOOK PROVING GROUND, JUNE 24, 1892.

Respectfully returned to the Chief of Ordnance, U. S. Army, with record of test of six shrapnel by firing * * * (with sensitive point percussion fuse through screen at 1,000 yards to compare with similar tests made of the Hotchkiss and the electrically welded shrapnel). Drawings are also forwarded showing the point struck on screen and corresponding targets for each shot. Tables 1 and 2 are appended. In Table 1 the targets are all reduced to 11 by 52 feet, the size used with the Hotchkiss shrapnel, the portions of each target being so selected as to bring the tops of the portions used the same distance, viz, 1 foot below the point of burst in each case. Table 2 gives the comparative results as actually obtained with the electrically welded and Frankford Arsenal shrapnel on the full targets, 18 by 52. The figures for the Hotchkiss and electrically welded shrapnel are taken from the tables accompanying my report of January 27, 1892.

With the Frankford Arsenal shrapnel the number of fragments is usually greater than the number called for on the drawing, showing that the separators broke up into smaller fragments than was anticipated, and it was found that as a rule the holes made by the fragments were very small, making it difficult to distinguish them from the holes made by the bullets.

FRANK HEATH,
Captain, Ord. Dept., U. S. Army, Commanding.

NOTE.—The firing records of six shrapnel, antecedent to the preceding, fired into a sand butt at close range to test the strength of the construction, are also subjoined.

TABLE No. 1.

Comparative results with one each electric welded, Hotchkiss, and Frankford Arsenal shrapnel, to determine dispersion, etc.

[Screen 90 feet in front of target; target 11 by 52 feet; target 1,000 yards from gun; screen 18 feet high, 13 feet wide.]

ELECTRIC WELDED SHRAPNEL.

Point struck on screen.		Balls.			Fragments.			Total hits.
Above top.	Left of center.	Through.	Imbedded.	Indents.	Through.	Imbedded.	Indents.	
	Ft. In.							
1	4 6	85	1	1	4	0	0	91

HOTCHKISS SHRAPNEL.

1	1 6	73	12	0	27	3	0	115

FRANKFORD ARSENAL SHRAPNEL NO. 1, IRON.

1	0 8	98	0	0	35	11	6	*150
1	3 0	77	1	0	42	20	29	†169

* Fig. 1. † Fig. 2.

FRANKFORD ARSENAL SHRAPNEL NO. 1, STEEL.

1	3 0	80	0	1	29	11	8	*129
1	2 0	.....	.....	.....	.....	.....	.....	(†)

* Fig. 1. † Fig. 2.

No. 1, steel, Fig. 2, struck 2 feet too low and could not be used for comparison.

FRANKFORD ARSENAL SHRAPNEL NO. 2, IRON.

1	4 0	126	0	0	58	15	3	202

TABLE No. 2.

Comparative results with electric welded and Frankford Arsenal shrapnel, to determine dispersion, etc.

[Target 1,000 yards from gun; screen 90 feet from target; target 18 by 52 feet; screen 18 feet high, 13 feet wide.]

ELECTRIC WELDED SHRAPNEL.

Point struck from center.		Mean two shots.						
		Balls.			Fragments.			Total hits.
Above.	Left.	Through.	Imbedded.	Indents.	Through.	Imbedded.	Indents.	
Ft. In.	*Ft. In.*							
6 3	4 6	118	2	2	6	3	0	131
6 0	2 6	151	10	8	5	5	0	179
Mean.	.....	135	6	5	6	4	0	155

FRANKFORD ARSENAL SHRAPNEL NO. 1, IRON.

7 0	8 0	124	0	0	54	12	8	*198
3 0	3 0	126	1	0	76	46	26	†275
Mean.	.....	125	1	0	65	29	17	237

FRANKFORD ARSENAL SHRAPNEL NO. 1, STEEL.

6 0	3 0	127	0	2	47	12	12	*200
0 0	2 0	195	2	5	70	47	18	†337
Mean.	.....	161	1	4	59	30	15	269

*Fig. 1. † Fig. 2.

FRANKFORD ARSENAL SHRAPNEL, M, NO. 2, IRON.

4 0	4 0	173	0	0	86	24	5	288

Record of firing with 3.2-inch B. L. rifle (steel), No. 18,

[Object of firing, test of

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Deflection points.	Recoil.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′		*Feet.*
Apr. 15	1650	Du Pont's I. K. H., lot 29; density, 1.725; granulation, 2,405.	3 12	Frankford Arsenal shrapnel, lot 371.	13 10	including nose plug.	.....	4
Apr. 15	1651		3 12		13 9	including nose plug.	.....	4
Apr. 15	1652		3 12		13 9	including nose plug.	.....	4
Apr. 15	1653		3 12		13 9	including nose plug.	.....	4
Apr. 15	1654		3 12		13 5	including nose plug.	.....	4
Apr. 15	1655		3 12		13 5	including nose plug.	.....	4

West Point Foundry, at Sandy Hook, N. J., April 15, 1892.

Frankford Arsenal shrapnel.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
From left and front 15°, 6 miles an hour.	Marks below band on shrapnel: "Model 1, Fig. 1, steel;" on body large S; on head small Fig. 3. Shrapnel found in sand with point turned almost completely towards gun. A portion of cast-iron powder chamber at joint of body about three-quarters of the way around and about $\frac{1}{16}$ inch wide stripped up, due to forcing of body on head from impact in sand. Slight marks of rifling about place for bourrelet. Marks below band on shrapnel: "Model 1, Fig. 2, steel;" large S on body. Shrapnel found in sand with point turned almost completely towards gun. Body stripped to the rear on threads of cast-iron powder chamber. A portion of threaded part stripped off and entirely separated from rest of shrapnel. No marks of rifling visible. With exception noted shrapnel apparently uninjured. Marks below band on shrapnel: "Model 1, Fig. 1, iron;" Fig. 6 on head and body. Shrapnel when found standing up nearly vertical and inclined towards gun. Joint of cast-iron powder chamber with body slightly opened and forced slightly upward and outward part way around, due to forcing of body on head caused by resistance of sand. No marks of rifling visible. Otherwise apparently uninjured. Marks below band on shrapnel: "Model 1, Fig. 2, iron;" Fig. 4 on head. Shrapnel when found turned to the right at right angles to line of fire. Crack in cast-iron powder chamber extending upward from joint for about three-fourths of an inch. Joint of head and body slightly opened. Cast-iron powder chamber forced very slightly outward and upward at joint, caused by forcing of body on head in the sand. Otherwise shrapnel uninjured. No marks of rifling visible. Marks below band: "Model 2, steel." Shrapnel broke up in sand. Base recovered badly broken, with a mass of bullets and separators firmly attached. Head recovered in one piece, divided at one of the outside weakening scores and broken from body where welded. Portion of powder chamber recovered having attached mass of bullets and separators, and also threaded portion of brass nose plug; 1 fragment of body, consisting of 2 segments, recovered, badly bent; 22 fragments of body badly bent and twisted; 4 fragments of rotating band, and a number of balls and separators. Marks below band: "Model 2, iron." Shrapnel broke up in sand. Fragments recovered. Top portion of nose plug. Head in one piece, separated from body where welded, contains portion of powder chamber and threaded portion of nose plug. One base entire, having places for 22 balls. Base recovered does not apparently conform to drawings of model 2. Five fragments of powder chamber, having mass of bullets attached; 23 fragments of body; 3 fragments of rotating band; 3 large masses of bullets and separators.	Gun mounted on Buffington steel field carriage No. 1. Bow-spring brakes. Cannon friction primers (experimental), wax stoppers, January 23, 1892. Carriage standing on soft sand. Fired into natural sand bank 25 feet in front of gun. Cannon friction primers (experimental), wax stoppers, January 23, 1892. Carriage standing on soft sand. Fired into natural sand bank 25 feet in front of gun. Breechblock closed with difficulty at each round. Mallet used. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.

Record of firing with 3.2-inch B. L. rifle (steel), No. 32, Watervleit

[Object of firing, to obtain targets

Date.	No. of fire.	Powder.		Projectile.		Elevation.	Deflection, points.	Recoil.
		Kind.	Weight.	Kind.	Weight.			
P. M.			*Lbs. Oz.*		*Lbs. Oz.*	° ′ *Quadrant.*	*Right.*	*Feet.*
June 13	104	Du Pont's I. K. H., lot 29; density, 1.725; granulation, 2,405.	3 12	Shell, lot 374, with band ⅝ inch from base.	13 6 2 sand. 13 8	1 2½	½	4
						French quadrant.		
June 13	105		3 12		13 3 5 sand. 13 8	1 00	½	4
A. M. June 14	106		3 12		13 3 5 sand. 13 8	1 00	0	4
June 14	107		3 12	Shell, lot 374, with band ⅝ inch from base. Fuses. Frankford Arsenal point percussion fuse. Lot 387.	13 6 including fuse. 3½ powder, bursting charge. 13 9½	1 00	*Left.* ¾	4
P. M. June 14	108		3 12		13 6 including fuse. 3½ powder, bursting charge. 13 9½	1 00	¾	4
June 14	109		3 12	Frankford Arsenal shrapnel, with Frankford Arsenal point percussion fuse. Lot 386. Lot 387.	13 6 including fuse. 3½ powder, bursting charge. 13 9½	1 00	¾	4

Arsenal, at Sandy Hook, N. J., June 13 and 14, 1892.

with Frankford Arsenal shrapnel.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
June 13, from front and right 15°, 4 miles an hour; June 14, from front, 6 miles an hour.	Sighting shot. Struck the ground 300 yards in rear of target.	Gun mounted on Buffington steel field carriage No. 5. Bow-spring brakes. Cannon friction primers, model, 1887; Frankford Arsenal, January, 1890. Fired to burst on passing through screen, placed 90 feet in front of 1,000-yards target. Screen 18 feet high, 13 feet wide, and 1 inch thick. Target 18 feet high, 52 feet wide, and 1 inch thick. Telescopic sight used. Gun on soft sand near 10-inch B. L. rifle. M, No. 1, Fig. 1, steel, calipered without fuse, 7.36 inches. M, No. 1, Fig. 1, iron, calipered without fuse, 7,385 inches. M, No. 1, Fig. 2, steel, calipered without fuse, 7.38 inches. June 14, barometer, 30.13; thermometer, 88°; humidity, 51.
	Sighting shot. Struck screen 1½ feet above and 3 feet right of center. [It was found after this round that the screen was not properly placed and firing was discontinued for the day.]	
	Sighting shot. Struck screen 6 feet above and 4½ feet right of center. Struck target 4 feet above and 6½ feet right of center.	
	Shrapnel marked M, No. 1, Fig. 1, steel. Shrapnel struck screen 6 feet above and 3 feet left of center, passed through and burst. Number of hits on target as follows: Balls through ..... 127 Balls imbedded ..... 0 Balls made mark ..... 2 Fragments through ..... 47 Fragments imbedded ..... 12 Fragments made mark ..... 12 Total 200	
	Shrapnel marked M, No. 1, Fig. 1, iron. Shrapnel struck screen 7 feet above and 8 inches left of center, passed through and burst. Number of hits on target as follows: Balls through ..... 124 Balls imbedded ..... 0 Balls made mark ..... 0 Fragments through ..... 54 Fragments imbedded ..... 12 Fragments made mark ..... 8 Total 198	
	Sharpnel marked M, No. 1, Fig. 2, steel. Shrapnel struck screen 2 feet left of center, passed through and burst. Number of hits on target as follows: Balls through ..... 195 Balls imbedded ..... 2 Balls made mark ..... 5 Fragments through ..... 70 Fragments imbedded ..... 47 Fragments made mark ..... 18 **Total 337**	

Record of firing with 3.2-inch B. L. rifle (steel), No. 32,

[Object of firing, to obtain targets

Date.	No. of fire.	Powder.		Projectile.			Elevation.	Deflection, points left.	Recoil.
		Kind.	Weight.	Kind.	Weight.				
A. M.			*Lbs. Oz.*		*Lbs. Oz.*		° ′		*Feet.*
June 17	114	Du Pont's I. K. H., lot 29; density, 1.725; granulation, 2,605.	3 12	Shell, lot 374.	13 1 7	sand.	1 00	2	4
					13 8				
P. M.									
June 17	115		3 12	Frankford Arsenal shrapnel, with Frankford Arsenal point percussion fuse. Lot 386.	13 8 3	including fuse. powder, bursting charge.	1 00	2	4
					13 11				
June 17	116		3 12		13 6 3½	including fuse. powder, bursting charge.	1 00	2	4
				Lot 387.	13 9½				
June 17	117		3 12		13 7 3½	including fuse. powder, bursting charge.	1 00	2	4
				Lot 386.	13 10½				

Watervliet Arsenal, at Sandy Hook, N. J., June 17, 1892.

with Frankford Arsenal shrapnel.]

Wind, strength and direction.	Special remarks about each fire, such as effect on piece, action of breech mechanism, consumption of powder, sound of projectile in flight, scattering of fragments, etc., and metrological data.	General remarks.
From right 90°, 8 miles an hour.	Sighting shot. Struck screen 3 feet above and 2 feet left of center; passed through; struck target about center.	Gun mounted on Buffington steel field carriage No. 5. Bow-spring brakes. Cannon friction primers, model 1887; Frankford Arsenal, January, 1891. Fired to burst on passing through screen, placed 90 feet in front of 1,000-yards target. Screen 18 feet high, 13 feet wide, and 1 inch thick. Target 52 feet wide, 18 feet high, and 1 inch thick. Telescopic sight used. M, No. 1, Fig. 2, iron, calipered without fuse, 7.35 inches. M, No. 2, steel, calipered without fuse, 7.58 inches. M, No. 2, iron, calipered without fuse, 7.59 inches. Barometer, 30.27; thermometer, 84°; humidity, 66. Firing conducted by Lieut. C. B. Wheeler, Ordnance Department, assistant proof officer.
	Shrapnel marked M, No. 1, Fig. 2, iron. Shrapnel struck screen 3 feet above and 3 feet left of center, passed through and burst. Number of hits on target as follows: Balls through ..... 126 Balls imbedded ..... 1 Balls made mark ..... 0 Fragments through ..... 76 Fragments imbedded ..... 46 Fragments made mark ..... 26 Total 275	
	Shrapnel marked M, No. 2, steel. Shrapnel broke up in gun.	
	Shrapnel marked M, No. 2, iron. Shrapnel struck screen 4 feet above and 4 feet left of center, passed through and burst. Number of hits on target as follows: Balls through ..... 173 Balls imbedded ..... 0 Balls made mark ..... 0 Fragments through ..... 86 Fragments imbedded ..... 24 Fragments made mark ..... 5 Total 288	

THE FRANKFORD ARSENAL SHRAPNEL FOR 3.2 INCH B.L. RIFLE

Frankford Arsenal
SEPTEMBER 1892

LIEUT. COLONEL OF ORDNANCE
COMMANDING

FIG. I

FIG. II

SECTION ON A.B.

FIG. IV

FIG. V

FIG. VI

FIG. VII

FIG. III

LEGEND

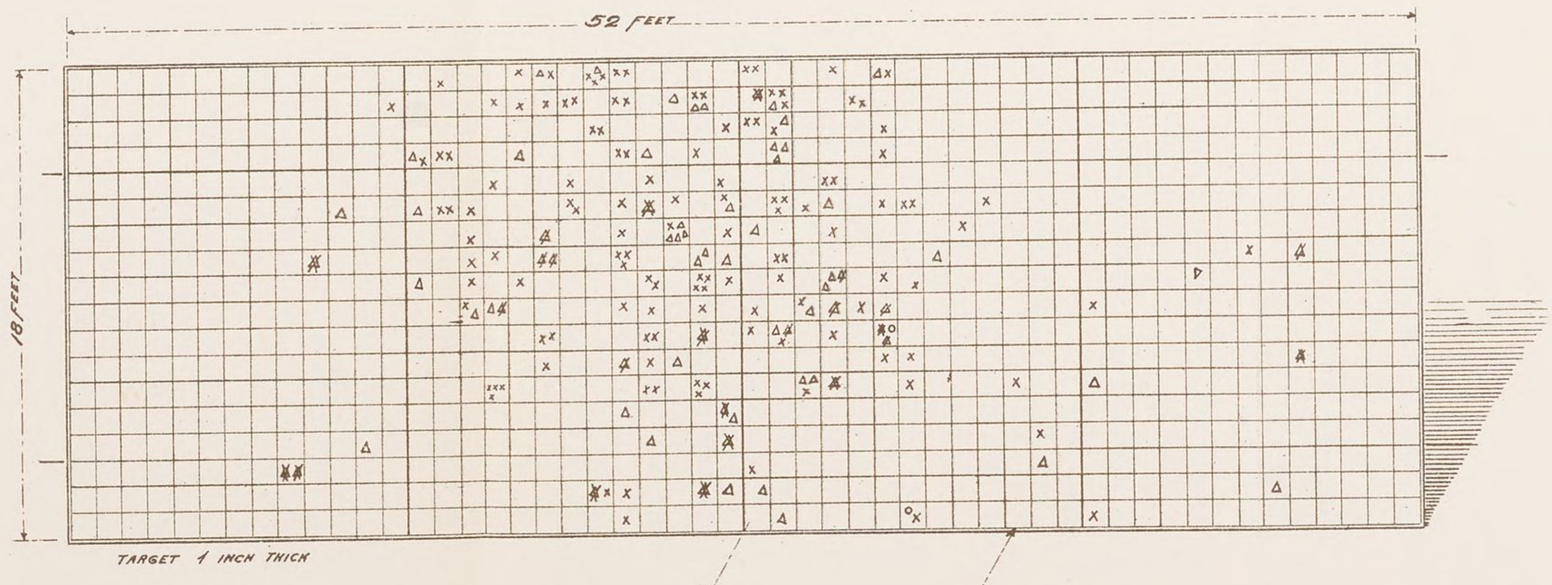
a	HEAD – CAST IRON	No OF PIECES	1
b	BODY –	"	1
c	BASE – CAST IRON	"	1
d	BAND – COPPER	"	1
e	TOP SEPARATOR – CAST IRON	"	1
f	FULL RING CENTRAL SEPARATOR – CAST IRON	"	1
g	HALF RING	"	10
h	FULL RING SEPARATOR	"	1
i	4 BALLS SEGMENT SEPARATOR	"	10
i'	3	"	10
k	BOTTOM SEPARATOR	"	1
l	BALLS – LEAD & ANTIMONY	"	162
	TOTAL No OF PIECES		200

Approved:

D W Flagler
Brigadier General,
Chief of Ordnance.

Appendix 46, 1892.

SCALE OF INCHES



X	BULLETS THROUGH	127
⊗	" IMBEDDED	0
○	" MADE MARK	2
△	FRAGMENTS THROUGH	47
⧋	" IMBEDDED	12
⧋	" MADE MARK	12
	TOTAL	200

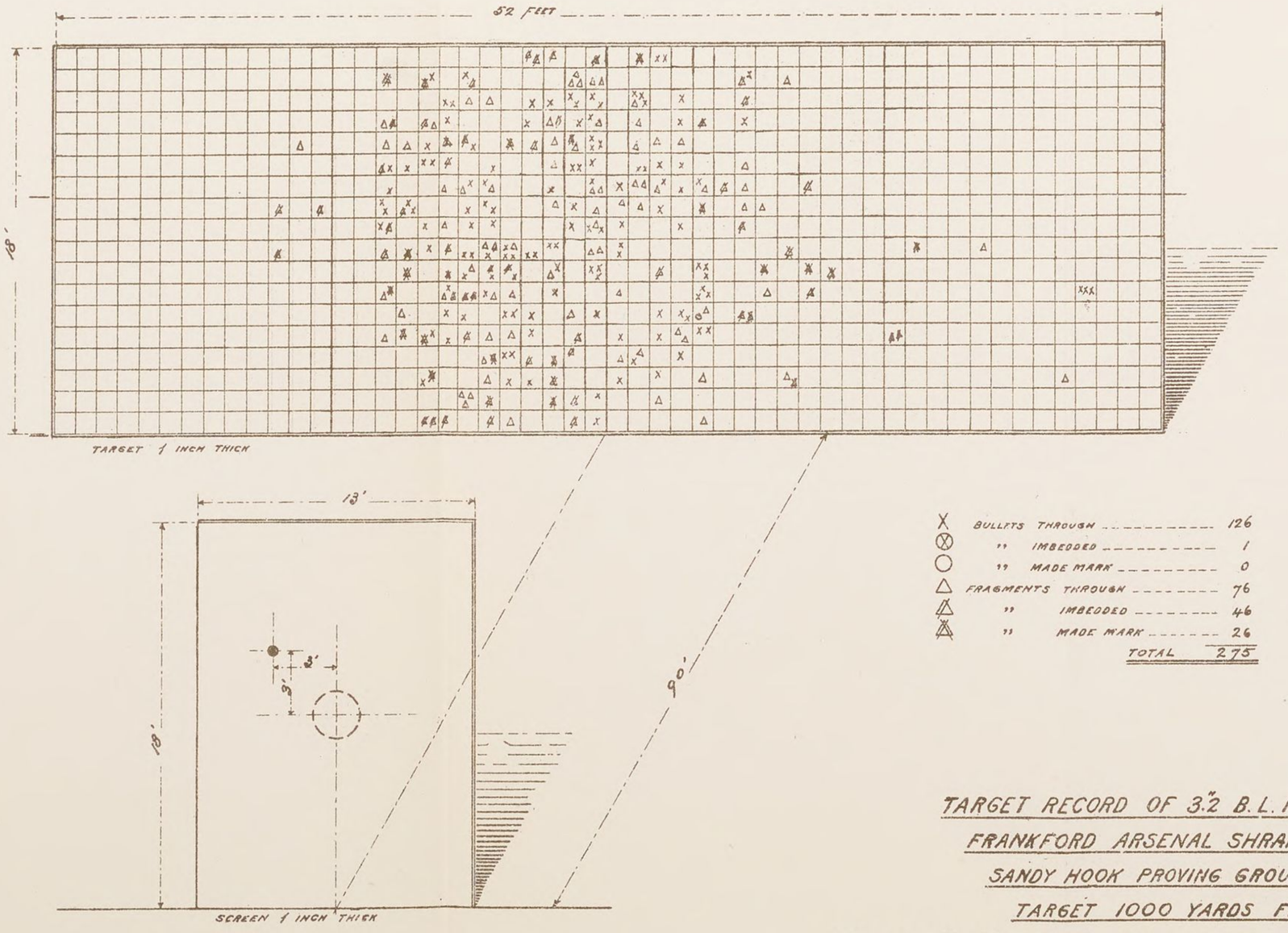
WIND 6 MILES PER HOUR. From Front.

TARGET RECORD OF 3.2 B.L. RIFLE, STEEL, No 32.
FRANKFORD ARSENAL SHRAPNEL, LOT 387,
AT SANDY HOOK, N.J. JUNE 14TH 1892.
TARGET 1000 YARDS FROM GUN.

FIRST SHOT, M, No 1, FIG. 1, STEEL.

Frank Heath
CAPTAIN ORDNANCE DEPT. COMMANDING
SANDY HOOK PROVING GROUND.

Charles D. Rhodes
LIEUT. ORDNANCE DEPT. U.S.A.



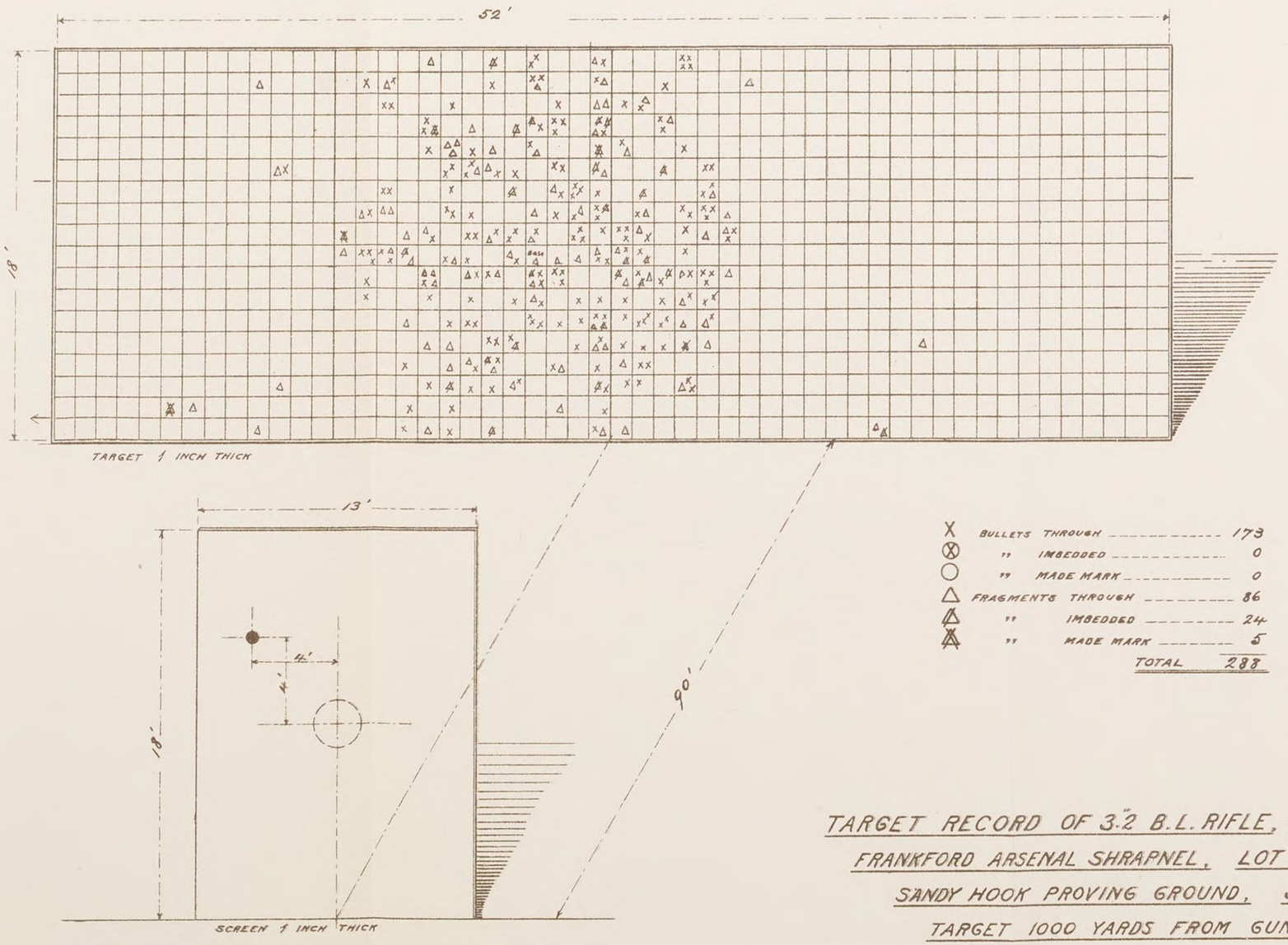
X	BULLETS THROUGH	126
⊗	" IMBEDDED	1
○	" MADE MARK	0
△	FRAGMENTS THROUGH	76
⧋	" IMBEDDED	46
⧋	" MADE MARK	26
	TOTAL	275

TARGET RECORD OF 3.2" B.L. RIFLE, STEEL, N°32.
FRANKFORD ARSENAL SHRAPNEL, LOT 386.
SANDY HOOK PROVING GROUND, JUNE 17TH 1892.
TARGET 1000 YARDS FROM GUN.
4TH SHOT, M. N°1, FIG. 2, Iron.

WIND 8 MILES PER HOUR, FROM RIGHT 90°.

Frank Heath
CAPTAIN ORDNANCE DEPT. U.S.A.
SANDY HOOK PROVING GROUND.

Charles D. Parkhurst
LIEUT. ORDNANCE DEPT. U.S.A.



X	BULLETS THROUGH	173
⊗	" IMBEDDED	0
○	" MADE MARK	0
△	FRAGMENTS THROUGH	86
⧋	" IMBEDDED	24
⧓	" MADE MARK	5
	TOTAL	288

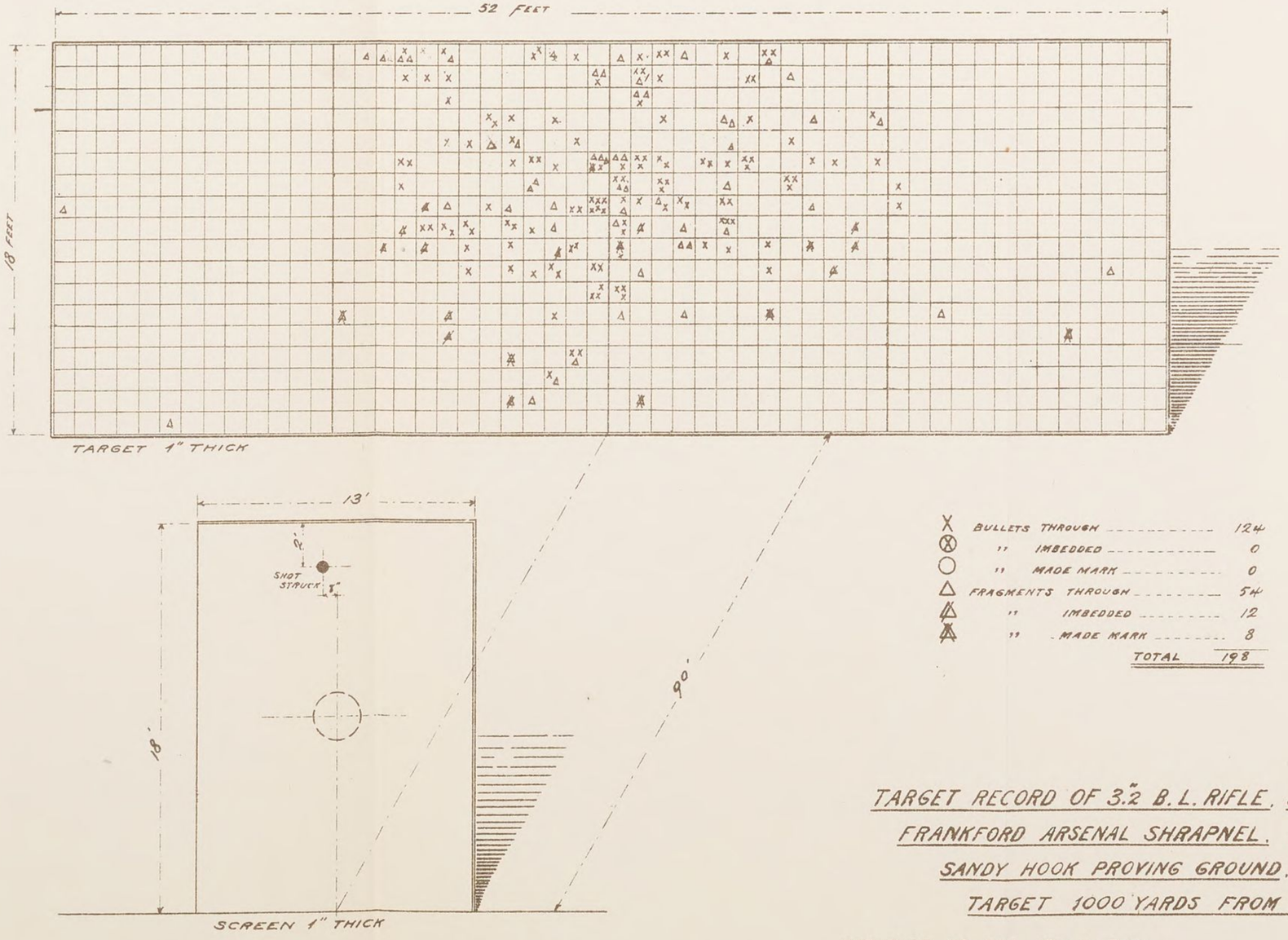
WIND 8 MILES PER HOUR, FROM RIGHT 90°

TARGET RECORD OF 3.2 B.L. RIFLE, STEEL, N°32.
FRANKFORD ARSENAL SHRAPNEL, LOT 386,
SANDY HOOK PROVING GROUND, JUNE 17TH 1892.
TARGET 1000 YARDS FROM GUN.

6th Shot, M. N°2. Iron.

Frank Heath
CAPTAIN ORDNANCE DEPT. U.S.A.
SANDY HOOK PROVING GROUND.

Charles D. Rhodes
LIEUT. ORDNANCE DEPT. U.S.A.



X	BULLETS THROUGH	124
⊗	" IMBEDDED	0
○	" MADE MARK	0
△	FRAGMENTS THROUGH	54
⧋	" IMBEDDED	12
⧋	" MADE MARK	8
	TOTAL	198

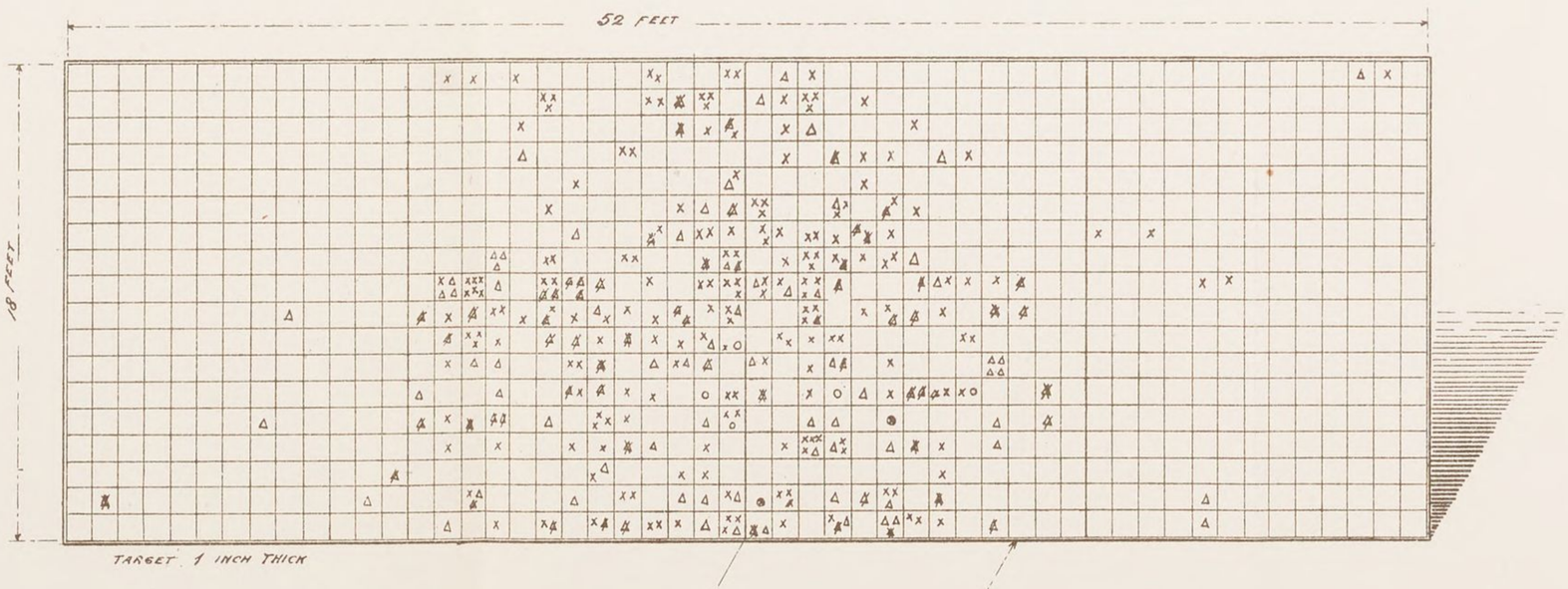
WIND 6 MILES PER HOUR, From Front.

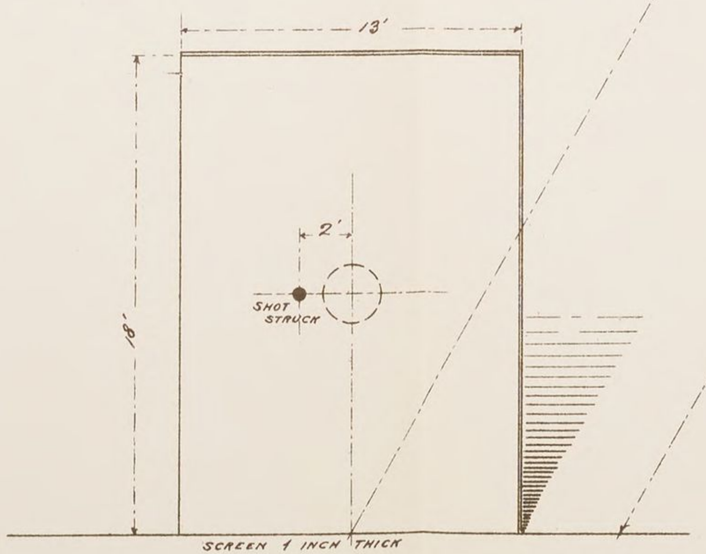
TARGET RECORD OF 3.2" B.L. RIFLE, STEEL, No 32.
FRANKFORD ARSENAL SHRAPNEL, LOT 386,
SANDY HOOK PROVING GROUND, JUNE 14TH 1892.
TARGET 1000 YARDS FROM GUN.

2ND SHOT, M. No 1, Fig. 1, Iron.

Frank Heath
CAPTAIN ORDNANCE DEPT. U.S.A. COMMANDING
SANDY HOOK PROVING GROUND.

Frederick D. Mahon
LIEUT. ORDNANCE DEPT. U.S.A.





X	BULLETS THROUGH	195
⊗	" IMBEDDED	2
○	" MADE MARK	5
△	FRAGMENTS THROUGH	70
⧋	" IMBEDDED	47
⧋	" MADE MARK	18
	TOTAL	337

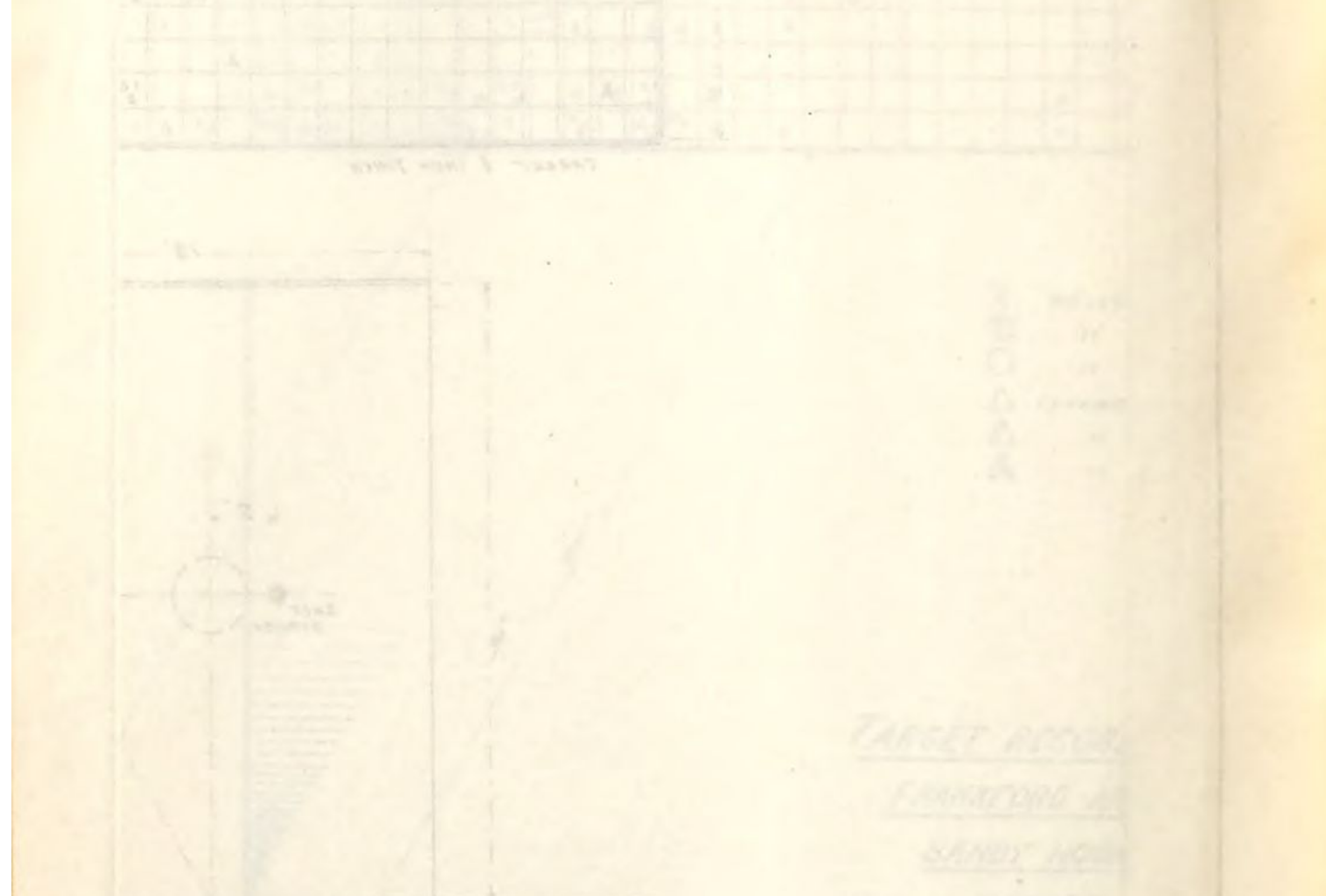
WIND 6 MILES PER HOUR, From Front

Frank Heath
CAPTAIN ORDNANCE DEPT. U.S.A. COMMANDING
SANDY HOOK PROVING GROUND.

TARGET RECORD OF 3.2" B.L. RIFLE. STEEL. N°32.
FRANKFORD ARSENAL SHRAPNEL. LOT 387.
SANDY HOOK PROVING GROUND. JUNE 14TH 1892.
TARGET 1000 YARDS FROM GUN.

3rd Shot. M. N°1. FIG. 2. STEEL.

Charles D. Parkhurst
LIEUT. ORDNANCE DEPT. U.S.A.



APPENDIX 47.

SPECIFICATIONS AND DRAWINGS OF THE HOTCHKISS AND THE AMERICAN PROJECTILE COMPANY 3.2-INCH SHRAPNEL.

(2 plates.)

GENERAL SPECIFICATIONS FOR 3.2-INCH SHRAPNEL.

The shrapnel are to be made complete in all respects, ready for the insertion of the bursting charge and fuse, in accordance with the drawings hereto attached and as herein specified.

The shrapnel shall be adapted to receive the Frankford Arsenal combination fuse, model of May, 1891. The case or part thereof inclosing the ball chamber must be not more than 0.25 of an inch in thickness, and made of drawn steel or lap-welded wrought-iron tubing. The powder chamber must have smooth surfaces throughout to avoid every danger of ignition of the powder from friction, and may be coated with lacquer or be tinned as a final operation. The size of chamber shall be such as will contain a sufficient bursting charge of powder, depending upon the construction of the shrapnel. The balls shall be round, of uniform size, and composed of an alloy of 90 parts lead and 10 parts antimony. Balls of either 0.5 or 0.526 of an inch in diameter (about 40 or 34 to the pound, respectively) may be chosen. They must be carefully packed in circular layers, and so held in position as to be secure against excessive dislodgment or deformation from the shock of discharge, and also so as to be readily separable under the action of the bursting charge in the shrapnel. The shrapnel should contain a maximum number of balls and be otherwise so arranged as a whole to give the greatest number of useful fragments from the remaining parts when burst.

Weight.—The weight of shrapnel, deducting the weight of plug, as furnished, and without fuse or bursting charge, shall be 12 pounds 4 ounces, with an allowed variation of plus or minus 2 ounces.

Dimensions.—The dimensions of the shrapnel are to be as shown on the drawings, subject to the variations established or usually allowed by the Ordnance Department for similar work.*

Material.—The material of the shrapnel, other than as herein specified, shall be of the kind designated on the drawings or in descrip-

*A table of dimensions and allowed variations, based on the drawings accompanying proposals, will be established by the Department to govern in the manufacture of the shrapnel. For guidance in making the drawings the following will be noted: The total length of shrapnel without fuse may not exceed 7.75 inches. A bourrelet or bearing band, 0.5 inch in width, 3.19 inches in diameter, and tangent at its forward end to the curve of head, may be placed below the base of head; the diameter of cylindrical portion in rear of bourrelet will be reduced to 3.17 inches. If no bourrelet is made the diameter of the cylindrical portion will be 3.185 inches. The radius of curvature of head should be not less than 3.5 inches.

tions accompanying proposals and of quality satisfactory to the Department.

The band will be of copper, and must, if required by the Department, be annealed before assembling. The surface under the band must be properly roughened to prevent slipping, and the band finally set in place by hammering or other approved methods.

The front face of head must be finished smooth and true, and the seat for fuse bored and threaded to fit standard gauges furnished by the Department. The rounded exterior surface of head need not be machine-finished if otherwise made smooth and of proper dimensions.

A plug of type metal, as shown on drawing, will be furnished with each shrapnel. The exterior of shrapnel, except band and the front face of head, will be neatly and evenly coated with a thin, black lacquer which must permit the passage of the maximum ring gauge over the projectile after it has been applied. When the shrapnel are packed for transportation the seat for fuse and front face of head must be free from rust, the latter well oiled, and the plug inserted.

The manufacture of the shrapnel shall be subject to the usual inspection by the Ordnance Department at all stages of the work, and the quality of workmanship and material shall comply in all respects with the usual standards established by the Department; and any parts of the material or shrapnel partly or wholly finished may be rejected for imperfect dimensions, imperfect welding, or for blow-holes or other defects which in the judgment of the inspector render the material unsuitable for its purpose. The finished shrapnel will be inspected and accepted at the place of manufacture subject to the following conditions: That 5 shrapnel, to be taken at random by the inspector from each 100 which are otherwise acceptable, shall be shipped to the proving ground, Sandy Hook, New Jersey, by the manufacturer, of which at least one shall be burst under cover, and not less than two, fitted with a blank point in place of fuse, and without bursting charge, shall be fired from the gun against a target of pine four inches in thickness placed in front of the proof butt. The shrapnel which are burst under cover must show rupture of the case and satisfactory separation of the balls, and those fired from the gun must not break before penetrating the target. Should failure result in either case these tests shall be repeated, and should more than one shrapnel of any lot of 5 so submitted fail in either one of the respects noted then the whole lot of 100 from which they were taken shall be rejected. If the tests are satisfactory the test lot of 5 shrapnel shall be included for acceptance in the whole lot which they represent. The manufacturer must provide a suitable number of blank points for the tests required.

The remaining shrapnel which will be delivered at the works of the manufacturer must be securely packed, without expense to the Government, in boxes containing 10 each, and marked for shipment by the Government as may be directed.

All details shall be subject to such slight changes, not materially affecting the cost of the work, as the Ordnance Department may wish to make as the work progresses, and any changes materially affecting the cost of manufacture will be paid for at a price to be satisfactory to the Chief of Ordnance.

D. W. FLAGLER,
Brig. Gen., Chief of Ordnance.

ORDNANCE OFFICE, WAR DEPARTMENT,
Washington, December 10, 1891.

ADDITIONAL SPECIFICATIONS FOR AMERICAN PROJECTILE COMPANY 3.2-INCH SHRAPNEL.

The following specifications, including table of weights, dimensions, and allowed variations, are made additional to those dated December 10, 1891, accompanying proposals for 3.2-inch shrapnel opened at this office January 28, 1892.

The entire case shall be made of wrought steel electrically welded together so as to form a complete hardened wrought-steel case without joint. The powder chamber to be formed in the base by a hard, wrought-steel diaphragm and connected through the center of the shell to the fuse opening by a small tube. The bullets to be 34 to the pound, and each shell to contain not less than 165 bullets, which will be held firmly in position by a matrix of resin.

A plug of hard wood, as shown on the accompanying drawing, will be furnished with each shrapnel in lieu of the type metal plug heretofore specified. And a browning process may, if made satisfactory to the Department, be used in place of a thin, black lacquer for coating the exterior of shrapnel.

The shrapnel will be made to the weight and dimensions shown on the accompanying drawing dated Ordnance Office, U. S. Army, March 9, 1892, variations therefrom to be allowed as follows:

Weight and dimensions.	Prescribed.	Allowed variations.
Weight (without fuse or bursting charge) .pounds..	12.25	2 ounces above or below.
Total length (without fuse) .....inches..	7.60	0.10 above or below.
Length of head (without fuse) .....do....	1.95	0.05 above or below.
Diameter of cylindrical portion .....do....	3.180	0.005 above or 0.01 below $\begin{cases} +0.005 \\ -0.01 \end{cases}$
Diameter of head at front .....do....	2.00	0.025 below.
Radius of head.....do....	3.5	
Thickness of base.....do....	0.70	0.02 above or below.
Thickness of diaphragm .....do....	0.375	0.03 below.
Thickness of walls:		
Powder chamber.....do....	0.35	0.02 above or below.
Cylinder ....do....	0.20	0.02 above or below.
Head, minimum.....do....	0.15	
Length of powder chamber .....do....	1.10	0.02 above or below.
Length of ball chamber .....do....	4.755	0.10 above or below.
Depth of fuse seat to end of thread, minimum .do....	1.20	
Totai depth of fuse seat .....do....	1.30	0.03 above or below.
Diameter of fuse seat within threads .....do....	1.00	} gauged.
Number of threads per inch .....number..	8.	}
Exterior diameter of tube (brass).....inches..	0.625	
Exterior diameter of band.....do....	3.30	0.005 above or below.
Width of band .....do....	0.50	0.01 above or below.
Distance of band from base .....do....	0.625	0.01 above or below.
Diameter of ball.....do....	0.526	
Weight of ball (34 to the pound).....grains..	206.	
Number of balls	170.	5 below.

NOTE.—The total weight of shrapnel to be 13.5 pounds, including fuse 1 pound and bursting charge 4 ounces to be supplied by the Ordnance Department.

The firing tests of the test lots of 5 shrapnel shall not be considered satisfactory and the lot of 100 shrapnel which they represent shall be subject to rejection, in the discretion of the Department, if the shrapnel fired from the gun show marks of rifling to such an extent as to indicate undue deformation of the shrapnel in the bore of gun.

D. W. FLAGLER,
Brig. Gen., Chief of Ordnance.

ORDNANCE OFFICE, WAR DEPARTMENT,
March 9, 1892.

ADDITIONAL SPECIFICATIONS FOR HOTCHKISS 3.2-INCH SHRAPNEL

The following specifications, including table of weights, dimensions, and allowed variations, are made additional to those dated December 10, 1891, accompanying proposals of 3.2-inch shrapnel opened at this office January 28, 1892:

The shrapnel, having a powder chamber to hold 3 ounces of powder contained in the head piece (grenade), and 162 balls packed in fragile cast-iron separators, will be made as shown on the accompanying drawing dated Ordnance Office, U. S. Army, March 10, 1892. It will be discretionary with the Department to use either form of band shown on the drawing, as may be hereafter decided upon. A plug of hard wood, as shown on the drawing, will be furnished with each shrapnel in lieu of the type-metal plug heretofore specified. And a browning process may, if made satisfactory to the Department, be used in place of a thin black lacquer for coating the exterior of shrapel.

Table of weights, dimensions, and allowed variations.

Weight and dimensions.	Prescribed.	Allowed variations.
Weight (without fuse or bursting charge) ... pounds	12	2 ounces above or below.
Weight (without fuse or bursting charge) ... ounces	5	
Total length (without fuse) ... inches	7.600	0.10 below; above ± 0″.10.
Length of head (without fuse) ... do	2.325	0.05 above or below.
Diameter of cylindrical portion ... do	3.180	0.005 above or 0.01 below + 0.005. — 0.01.
Diameter of head at front ... do	2.00	0.025 below.
Radius of head ... do	4.86	
Thickness of base ... do	0.30	
Thickness of separators ... do	0.50	
Thickness of walls:		
Powder chamber (head) ... do	0.39	
Cylinder ... do	0.20	
Length of powder chamber ... do	1.425	0.02 above or below.
Length of ball chamber ... do	4.50	
Depth of fuse seat to end of thread ... do	1.14	0.02 above or below.
Diameter of fuse seat within threads ... do	1.00	gauged.
Number of threads per inch ... number	8.00	gauged.
Exterior diameter of band ... inches	3.30	0.005 above or below.
Width of band ... do	0.50	0.01 above or below.
Distance of band from base ... do	0.625	0.01 above or below.
Diameter of ball ... do	0.50	
Weight of ball (40 to the pound) ... grains	177.	
Number of balls	162.	

NOTE.—The total weight of shrapnel to be 13.5 pounds, including fuse 1 pound and bursting charge 3 ounces, to be supplied by the Ordnance Department.

Where no allowed variations are stated, the actual variations must lie within the limits necessary to meet such variations as are allowed for the general dimensions of the shrapnel.

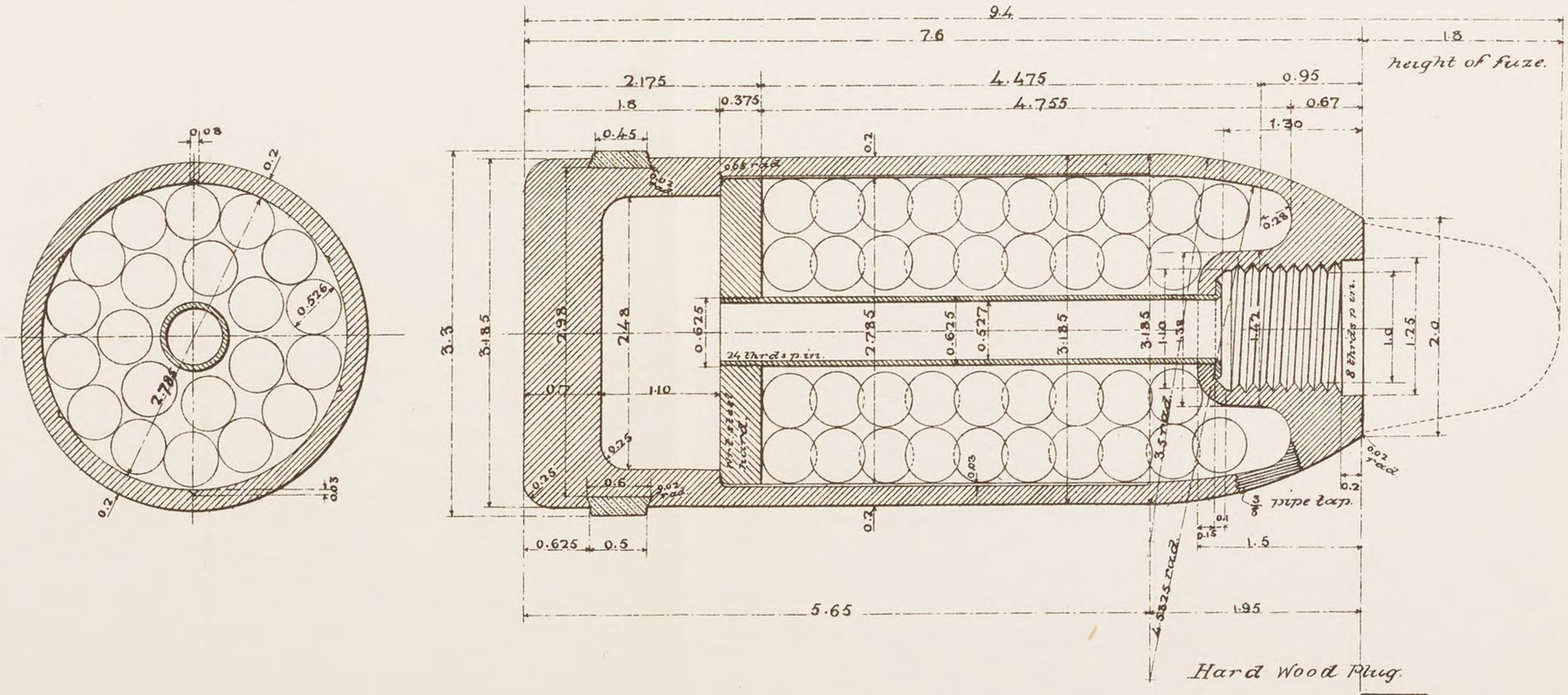
The firing tests of the test lots of 5 shrapnel shall not be considered satisfactory, and the lot of 100 shrapnel which they represent shall be subject to rejection in the discretion of the Department if the shrapnel fired from the gun show marks of rifling to such an extent as to indicate undue deformation of the sharpnel in the bore of gun.

D. W. FLAGLER,
Brig. Gen., Chief of Ordnance.

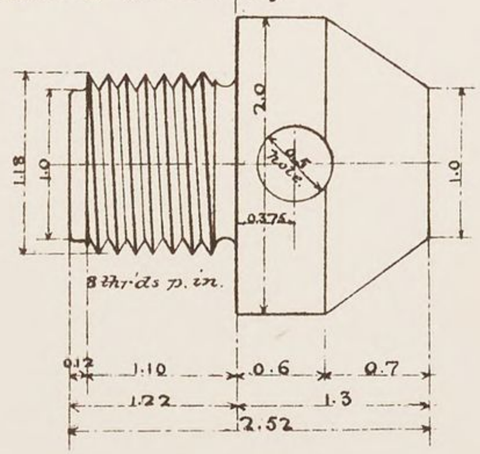
ORDNANCE OFFICE, WAR DEPARTMENT,
March 10, 1892.

SHRAPNEL FOR 3·2 INCH B. L. RIFLE.

Electrically Welded Case. Wrt. Steel, Hardened.



Hard Wood Plug.



Weight of Shrapnel	12	lbs.	4 ozs.
" " bursting charge	0	· 4	·
" " fuze	1	· 0	·
" loaded	13	· 8	·

170 Balls (90 lead, 10 antimony)
34 to the pound.

Provisionally Approved.

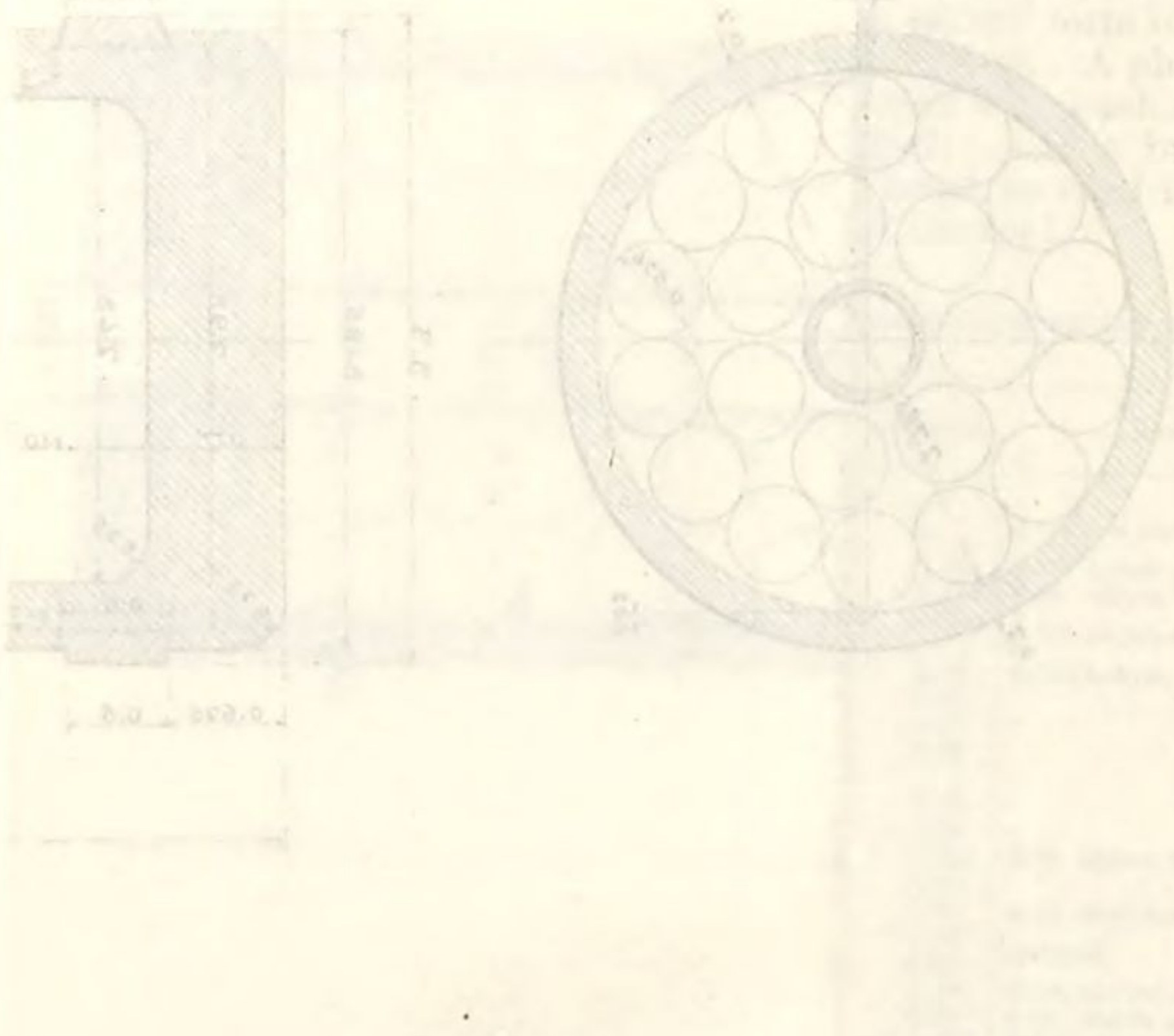
D W Flagler

Brigadier General
Chief of Ordnance

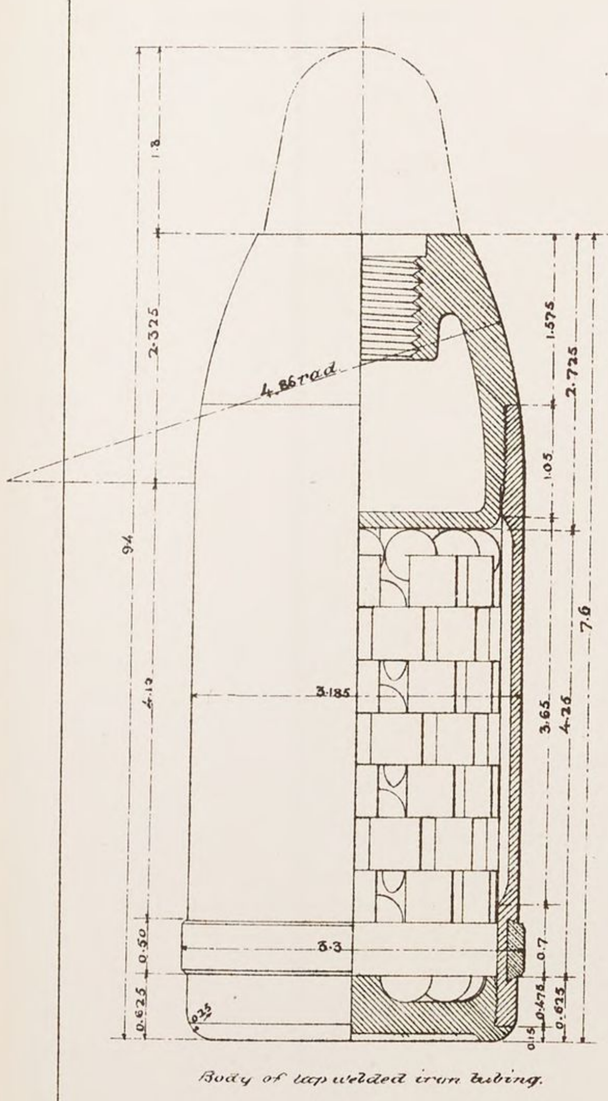
American Projectile Co.

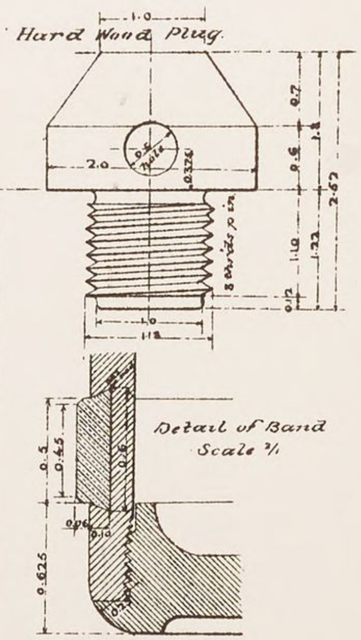
by W. M. Wood

W. Pres.

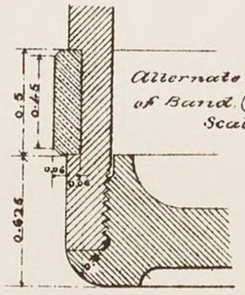


HOTCHKISS SHRAPNEL FOR 3·2 INCH B.L. RIFLE

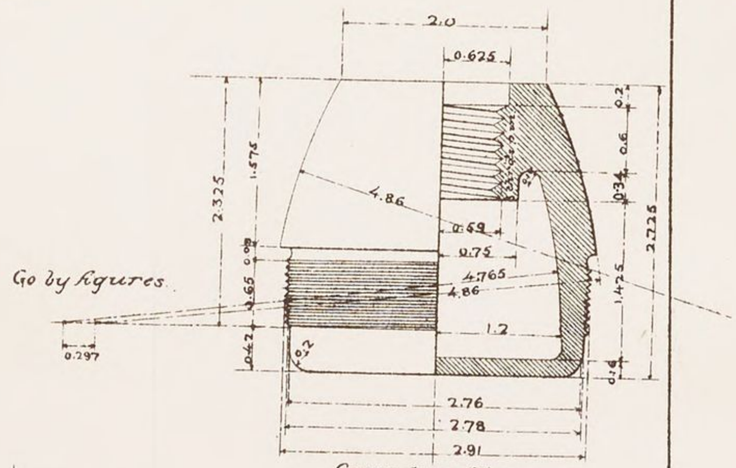




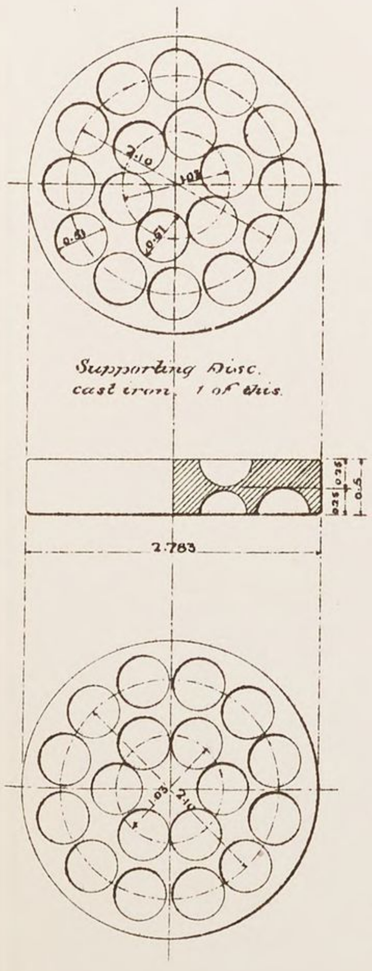
Detail of Band
Scale 2/1.


Alternate Detail
of Band. (solid drawn)
Scale 2/1

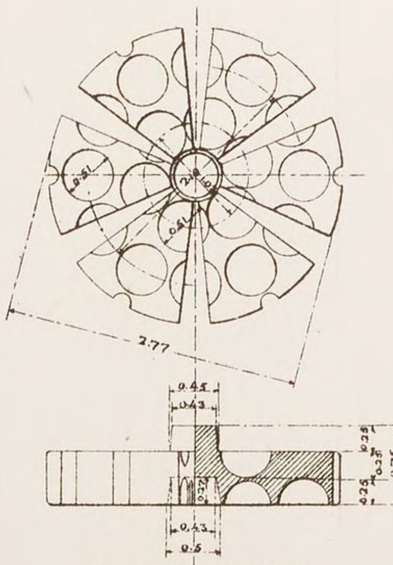
Weight of Shrapnel	12 lbs 5 ozs.
" " bursting charge	0 · 3 ·
" " fuze	1 · 0 ·
" loaded	13 · 8 ·



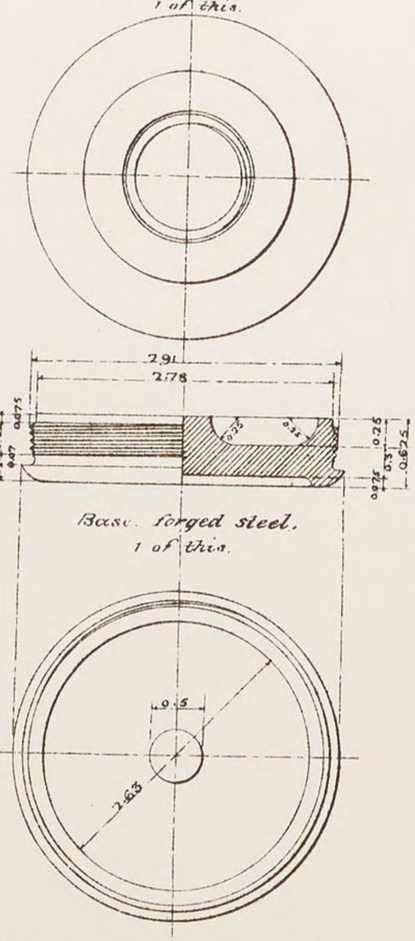
Grenade, cast iron.
1 of this.



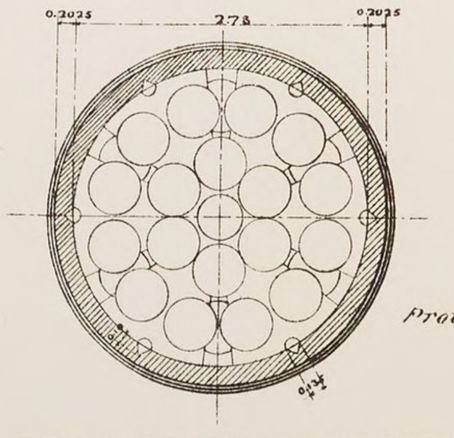
Supporting Disc.
cast iron. 1 of this.



Separator. cast iron.
7 of this.



Base. forged steel.
1 of this.



162 Balls.

Lead 90 %

Antimony 10 %

This dimension subject to slight alteration.

Provisionally Approved:

O. W. Flagler

Brigadier General
Chief of Ordnance.

Hotchkiss Ordnance Co. Ltd.

Edward W. Very
Attorney and Agent

Appendix 47, 1892.

APPENDIX 48.

REPORTS ON MEASURING AND INSPECTING INSTRUMENTS, BY LIEUT COL. D. W. FLAGLER, ORDNANCE DEPARTMENT, U. S. ARMY.

(4 plates.)

FRANKFORD ARSENAL, PA., *July 11, 1887.*

REPORT ON STAR GAUGE WITH INTERIOR AND EXTERIOR RESTS AND OTHER ATTACHMENTS RECOMMENDED.

Exterior rest for star gauge.

(Plate I.)

I have devised and submit herewith a star-gauge rest to stand on the ground and support the portion of the gauge which is outside the gun. This rest is shown on Pl. I. It is fully illustrated in the drawing, and not much description is required.

The tripod has extension legs, which, with other adjustments, admit of a vertical adjustment of $3\frac{1}{2}$ feet. The iron extension bars of the legs are made heavy, to give great stiffness, and also that the weight may give perfect stability. The elevating screw is for small vertical adjustments. It is operated with a nut in order that the rest may not revolve in elevating and depressing. After adjustment the lower nut locks the screw rigidly in position. The roller (*a*) is made of wood, covered with buff leather. It slides on its revolving axle to give lateral adjustments, and is fastened in position with a set screw. This is a cheap, substantial rest, quickly and easily adjusted, and not only supports the gauge, but, as the gauge moves on rollers, it avoids friction and lessens the labor of manipulation.

Adjustment of exterior star guage rests.

Fasten a fine cord at the center of plate (*b*); set this plate on one of the interior rests (to be described further on), and push this rest as far into the gun as is desirable. Set the plate (*c*) in another interior rest near the muzzle of the gun and pull the cord through the hole (*h*). The other end of the cord is then to be attached in its proper position to the exterior rest which is farthest from the gun. To make this attachment, first clamp the ring (*r*) around the roller of the rest, then lay the cord in the groove on the ring, and hang a heavy weight to the cord. Then adjust this rest till the cord is centered in the hole (*h*). The other intermediate rests can then be adjusted to the cord.

Interior rests for star gauge.

(Plate II.)

I have devised and submit herewith a roller rest for supporting the staff of the star gauge inside the gun. This rest is shown on Pl. II, herewith.

The roller is made of wood, covered with buff leather, and is secured to its axle, as in this case no adjustments are required. The axle is supported by a brass casting, consisting of a transom (A) and two semi-circular end plates (B B). For all sizes up to and including that for 6-inch guns the transom and end plates are cast in one piece (Fig. 1). For the 8-inch and larger sizes the end plates are attached to the transom with screws, and only one transom is required for all the large sizes (Fig. 2). This rest is cheap and substantial, and requires no adjustment. It carries the star gauge on rollers, avoids friction, and facilitates the manipulation of the gauge. When more than one rest is required, the wooden rod R (Fig. 2) is attached to the rest which is already in the bore of the gun. This rest is then pushed down the gun the length of the rod, and another rest is then put in the muzzle and attaches itself to the rod. More rests are added in the same way as required. In star gauging from the bottom of the bore forward, measurements are made till the star-gauge head comes up to a rest. Then the forward rest is removed and the others are pulled forward the length of a rod.

The attachment of the rods to the rests is as follows:

At each end of the rods are two notched or shouldered springs (S S). These are pushed into the holes (*h*) in the rest, spring outward and fasten themselves. Gravity adjusts the rests at or near the lower side of the bore. It is not necessary that they should be exactly at the lowest point, and they would work well when as far as ten degrees on either side of the lowest point. It is possible that in pushing them down the bore a burr on the gun's rifling may tend to carry them to one side. If so, shaking would cause them to settle at the lowest point, or if pushed beyond the required position and then drawn forward the rifling would run them down toward the lowest point. The plates for the attachment of and centering the cord in the axes of the bore, used in the adjustment of the outside rests, are set into the end plates of these rests.

(703–'87.)

NOTE.—*Four of each of these rests are now (October, 1892) being manufactured.* The interior rests are adapted for star-gauging the shrinkage as well as the finished bores of 8, 10, and 12 inch steel guns, and comprise, besides the connecting rods and loose plates for the attachment of and centering the cord in the axis of the bore, used in the adjustment of the outside rests, four transoms, complete with rollers, for common use, and the following removable end plates (B B) to fit the different bores, namely:

For 12-inch guns.—Four pairs of plates for 12-inch bore; four pairs of plates for 11.72-inch bore.

For 10-inch guns.—Three pairs of plates for 10-inch bore; three pairs of plates for 9.77-inch bore.

For 8-inch guns.—Two pairs of plates for 8-inch bore; two pairs of plates for 7.85-inch bore.

The smaller sizes of plates are intended for star-gauging the bores of the guns during the shrinkage operations, for which the following diameters are prescribed, viz: 8-inch gun, 7.875 inches; 10-inch gun, 9.8 inches; 12-inch gun, 11.75 inches. The plates are made for diameters from 0.02 inch to 0.03 inch smaller than these, as stated above, to allow for small variations in the boring and also for the contraction of bore which occurs during the shrinkage operations.

The number of plates (B B) will provide 2, 3, and 4 of the interior rests complete for the 8, 10, and 12 inch guns, respectively.

The connecting rods are made to give a clear length of 6 feet between the rests. Four of these rods are required for the set of rests, in order that, for the 12-inch gun, the fourth rod may be used for manipulating the system of three connected rests in the bore from the muzzle of the gun.

WATERTOWN ARSENAL,
Watertown, Mass., May 5, 1890.

REPORT ON EXTERIOR CALIPERS, GAUGES FOR SETTING THE SAME, AND SUSPENSION AND MANIPULATION OF EXTERIOR DIAMETER CALIPERS.

Exterior calipers.

In my judgment, exterior calipers can be made of wood that will fill the requirements better for lightness, stiffness, ease of manipulation, and economy (taking into account the large number desired) than if made of any other material. * * * Each caliper is provided with fixed metal sockets for carrying the measuring points. These sockets may be made of forged steel or cast brass. Mr. Howard prefers forged steel, but the necessary finishing of these would be expensive because of the large number required. I think cast brass, finished inexpensively on a wheel (except reaming out), would answer. The wood will warp and the axes of the two sockets will not remain accurately in line. When this occurs they are to be twisted into line, and set in line by running a bar through them. A sample 34-inch wood caliper with brass sockets is sent by express to illustrate the desigu better than the drawing.

Standard gauge rods for setting micrometers and points for interior and exterior diameters.

(Pl. III.)

The A rods are for setting the exterior calipers to required lengths, the B rods for setting the interior measuring points. The difference in length of successive rods is the length of the micrometer movement of the micrometer point, viz, 0.5+ inch. These rods are to be made of steel approximating in quality to the gun steel. They are cut off to the required lengths as nearly as possible, and their exact lengths are then determined on the comparator, and these lengths are then stamped on the rods.

(The proposed comparator is described in another report of this date from this arsenal.)

The rods, when measured on the comparator, are to be brought to the standard constant temperature of the comparator's standard bar. When used they are to be brought to the temperature of the gun, hoop, or piece to be measured.

The plus of the micrometer is to cover variations in lengths of the standard rods, as follows: Suppose the 20-inch standard rod is 0.02 inch shorter than 20 inches and the 20.5-inch rod is 0.02 inch longer than 20.5 inches. The difference between these sucessive rods is 0.54 inch, requiring a micrometer movement of 0.54 inch.

Succeeding gauge rods, both A and B, differ 0.5 inch, and a set of each from 9 inches to 45 inches is required.

It may be that for the larger sizes of the female gauges B the sliding gauge (Fig. 3, Pl. III), to be set to length with the gauge rods A, may be desirable. This would involve two settings, more chances of error, might require occasional reference to the comparator, and I prefer the other method.

Suspension and manipulation of exterior calipers.

The objections to the suspension spring are, its cost, difficulty of adjustment to required weight, the number required for various weights of calipers, lack of easy vertical movement, and consequent pull and distortion of a light caliper to overcome the tension of the spring.

I submit on Pl. IV a method of suspending a manipulating exterior caliper, which I recommend for adoption or trial.

The caliper is suspended in two places to avoid distortion from its own weight, for easier manipulation, and that it may not be unbalanced by moving the measuring points out and in. The weights *w w* are tin cups containing small shot, and are readily adjusted to any weight of caliper. The cords should be small fish line. The friction for a 2-pound caliper should not exceed 0.02 pound for moving one end of caliper up and down. The caliper can be easily pushed up out of the way or pulled to one side for adjusting the points, etc.

I think a wooden trestle like that shown on the same plate (Pl. IV) furnishes a good method for suspending the caliper. The details for it are not fixed. The peculiar arrangement suggested for the braces is to get them out of the way of the user. It is designed to be set up over a lathe or any piece to be measured. Two men should carry it and set it up in a few minutes.

The light weight of the wood caliper makes a pulley or trolley unnecessary. The wooden slide on the top beam is sufficient, and can be readily moved and adjusted with a cord as shown.

(2514–'92.)

WATERTOWN ARSENAL, *May 5, 1890.*

Respectfully returned to the Chief of Ordnance, U. S. Army, and attention asked to the second report of Mr. Howard, inclosed herewith.

After much investigation it is believed that the best method of procuring the desired comparator is for the Department to manufacture it substantially in the method described by Mr. Howard from the marked paragraph on page 8 to the end of the report.

• • • • • • •

It is urgently recommended that a linear dividing engine attachment be added to the comparator. It would not add materially to the cost.

It is also recommended that the comparator be made to measure not less than 80 inches. Although a 50-inch machine might meet present requirements, I think gauges 72 inches long will be needed in a few years.

With the dividing attachment the second graduated bar required for the 80-inch comparator could then be manufactured on the comparator, and if made here I think it could be investigated by Mr. Howard as efficiently as elsewhere.

The comparator as proposed is exactly adapted for establishing the lengths of the gauge rods described in my report (Pl. VI) on gun-inspecting instruments of this date.

The whole plan proposed would make only one comparator necessary for the Department, and the needful inspecting instruments, made at various places, with the standard gauge rods made on the one comparator, could be economically provided and sent wherever required.

The method proposes making the comparator an office rather than a shop machine, and of furnishing gauges established on it, for shop use,

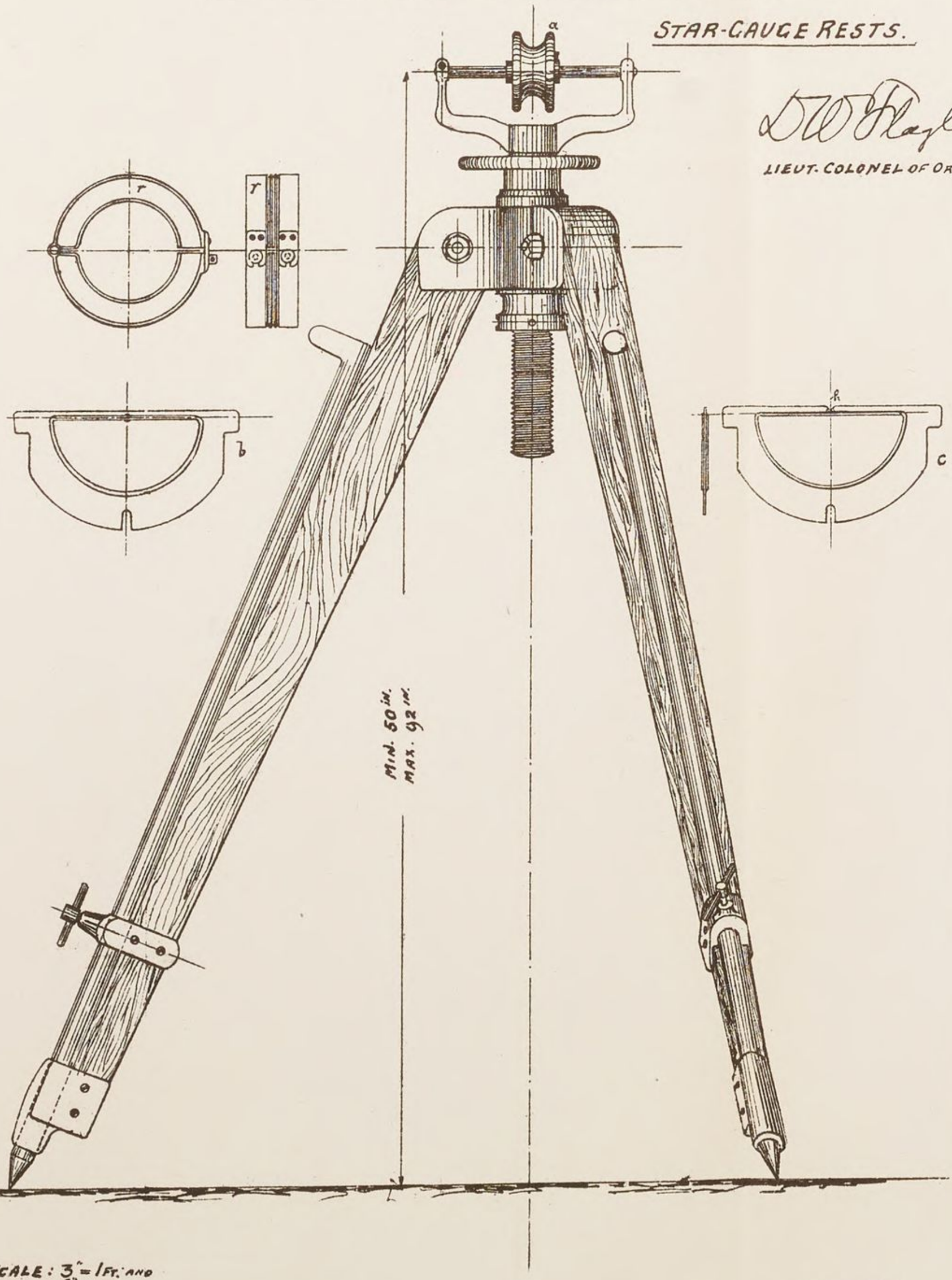
The dividing attachment would give the Department the means of furnishing to all the arsenals equal standard graduated bars, and also the means of providing a second comparator, if it should be needed, at a moderate cost, say $800.

SKETCH of PROPOSED INDEPENDENT OUTSIDE

STAR-GAUGE RESTS.

D W Flagler

LIEUT. COLONEL OF ORD.



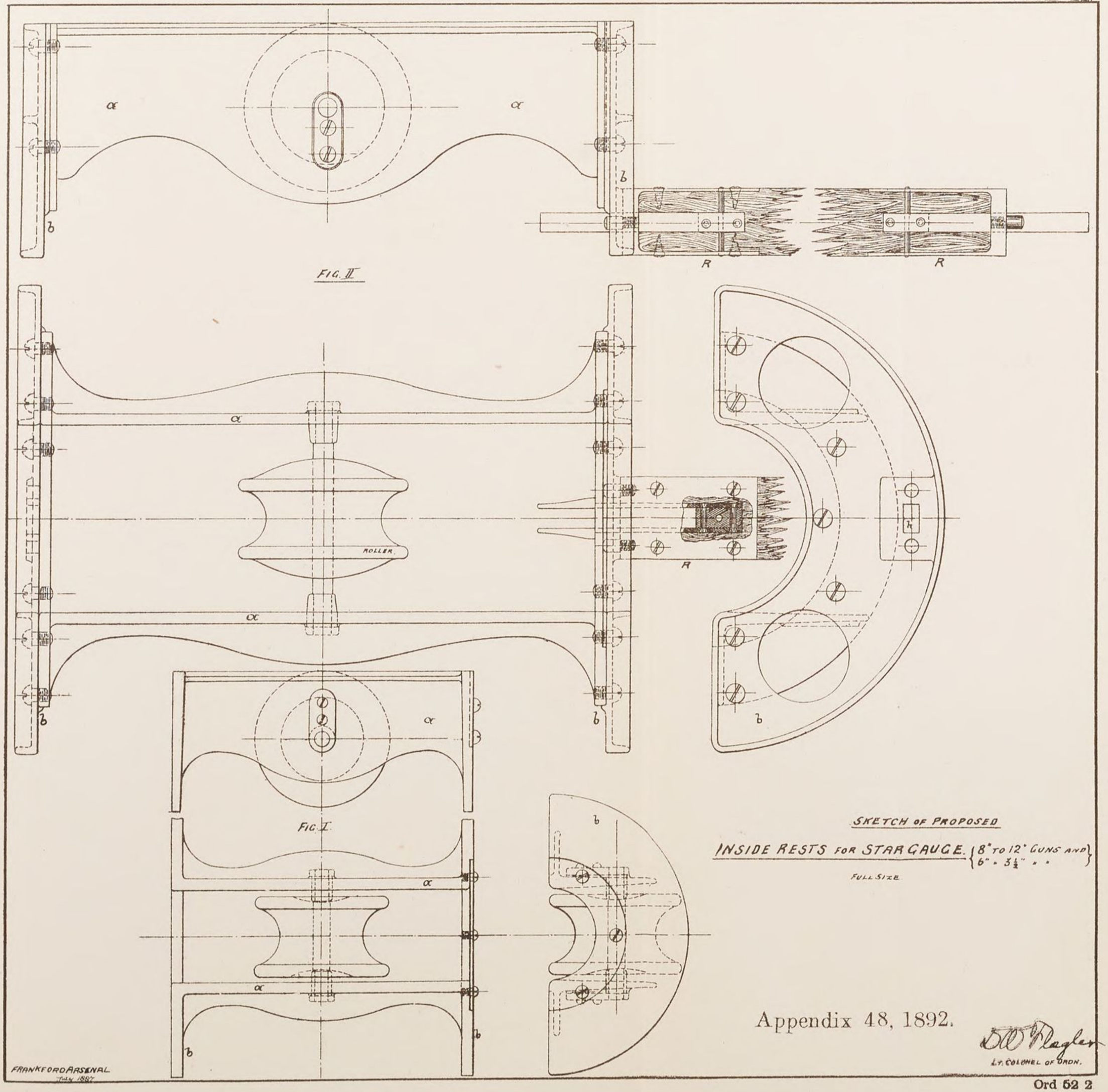


FIG. II

FIG. I

SKETCH OF PROPOSED

INSIDE RESTS FOR STAR GAUGE. { 8" TO 12" GUNS AND 6" " 3½" " "

FULL SIZE

FRANKFORD ARSENAL
JULY 1887

Appendix 48, 1892.

S O Flagler
LT. COLONEL OF ORDN.

Ord 52 2

Fig. II.

Standard female gauges for setting micrometers for interior diameters.

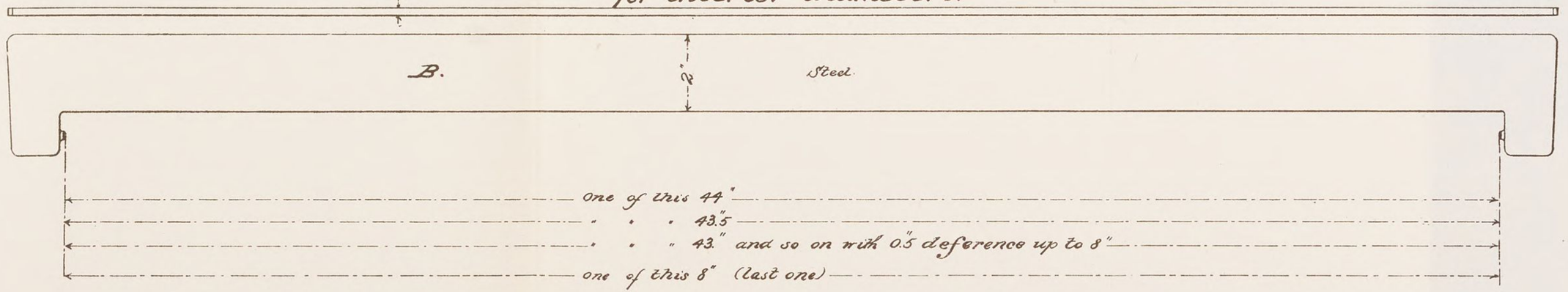


Fig. I.

Standard gauge rods for setting micrometers in exterior diameter calipers.

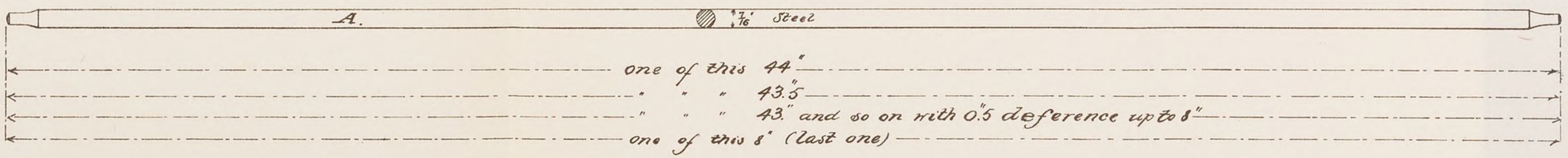
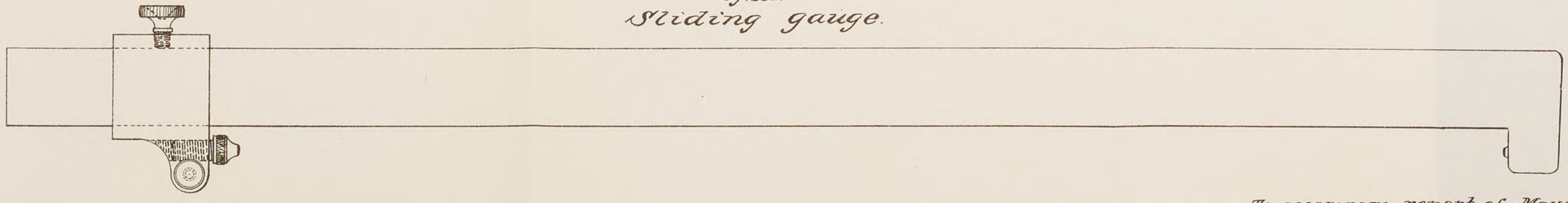


Fig. III.

Sliding gauge.



To accompany report of May 5th 1890

D W Flagler

Lieut. Colonel Ordnance Dpt.
Commanding.

Appendix 48, 1892.

Watertown Arsenal May 5th 1890.
S.H.

Suspension & Manipulation of Exterior Diameter Caliper.

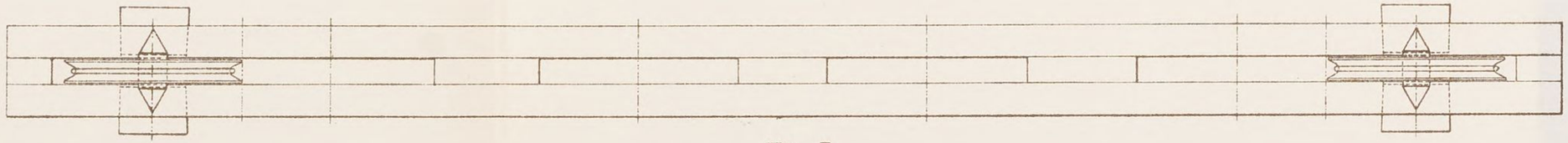
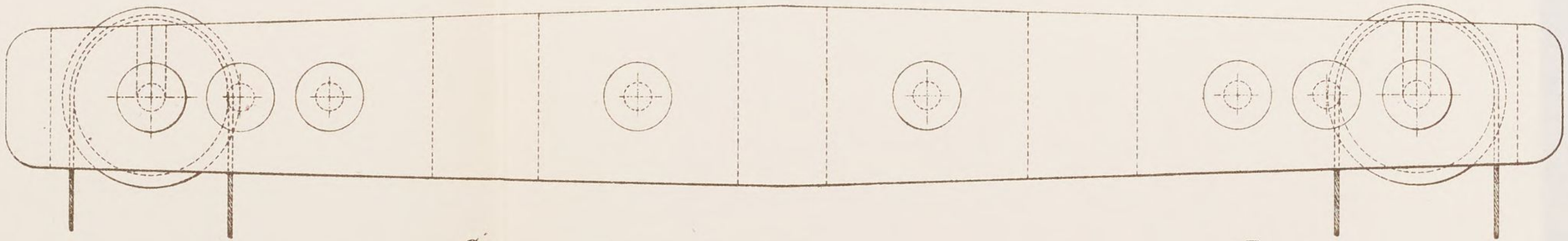


Fig I.



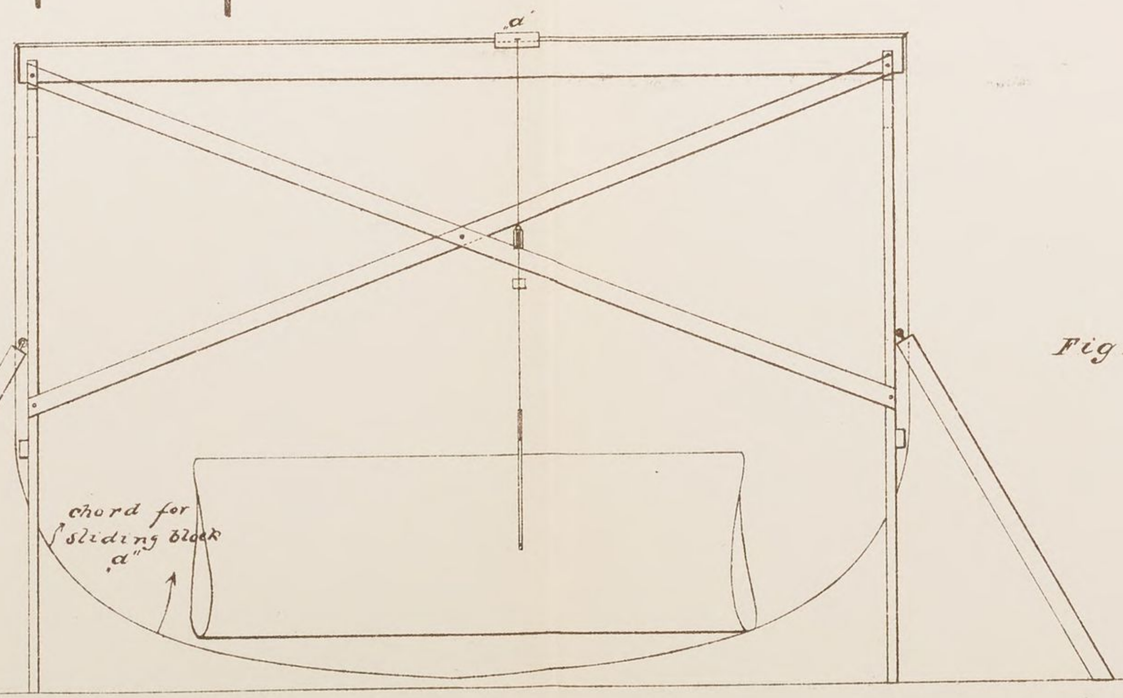
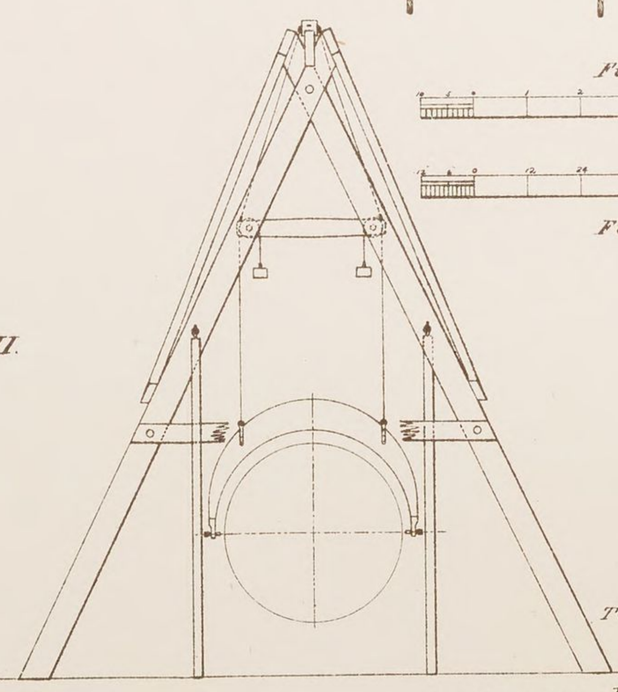


Fig II.



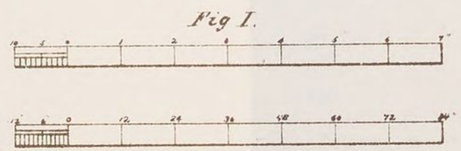


Fig I.

Fig II.

To accompany report of May 5th 1890.

D.W. Flagler
Lieut. Colonel Ordnance Dpt
Commanding.

Watertown Arsenal May 5th 1890.
F.E.

APPENDIX 49.

WOOD-FRAME CALIPERS AND APPURTENANCES FOR MEASURING EXTERIOR DIAMETERS.

(4 plates.)

WATERTOWN ARSENAL,
Watertown, Mass., June 15, 1892.

SIR: In compliance with your instructions of January 25, 1892, I have the honor to forward herewith drawings and description of wood-frame calipers and appurtenances, to embrace from 0 to 50 inches, to measure exterior diameters, together with an itemized statement of the cost.

Lieut. B. W. Dunn, Ordnance Department, my assistant, who designed these calipers, superintended their construction and furnished the description, reports that the following departures from previous patterns were adopted, with my approval:

(1) The frame-socket castings were made rectangular in cross section, and deeper to secure a more rigid attachment to frame.

(2) The thickness of parts of ball socket was made 0.25 inch instead of 0.125 inch to afford greater resistance to accidental cross stresses.

(3) Dowel pins were substituted for the knees and grooves formerly used in socket joint. They answer the purpose just as well and are cheaper.

The design for suspension apparatus was made by the writer after careful consideration. The photographs submitted by the inspectors at South Boston and at Cold Spring indicated that to use the arms without a specially designed apparatus is the source of great inconvenience, if not of inaccuracy.

* * * * * * *

The saddle-back suspension apparatus constructed at this arsenal on design of board of inspecting instruments is more expensive than the one proposed, and when successive measurements of diameters along axis of piece are required, the frequent shiftings and readjustments necessary would cause inconvenience and delay.

The apparatus constructed works well. The metal in some of the castings for clamps was of inferior quality, and for the future it is thought that hinged clamps for horizontal pipe would be better. The pipe could then be more readily adjusted, and it would not be necessary to detach the cord.

Very respectfully, your obedient servant,

J. W. REILLY,
Major, Ord. Dept., U. S. Army, Commanding.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

DESCRIPTION OF WOOD-FRAME CALIPERS AND APPURTENANCES FOR MEASURING EXTERIOR DIAMETERS.

I. CALIPERS.

(Pl. III.)

(a) *Frame.*

The frame is made of white pine, well seasoned. It was designed with a view to securing (1) stiffness, (2) lightness, and (3) economy. Each frame has a capacity of about 5 inches, *i. e.*, the difference between shortest and longest diameters that can be measured by it is about 5 inches. A set of 10 arms will, therefore, answer for measuring all diameters up to and including that of 12-inch B. L. steel rifle. Generally the lengths of corresponding pieces of frame, in arms of different capacities, vary as the capacities, while for economy in manufacture the cross section of pieces is kept constant. The frames of first two arms of set—capacities from 0 to 5 inches and from 5 to 10 inches—are made solid, as shown in drawing, the general contour of larger arms being preserved. Except where otherwise indicated in drawing the pieces are joined by screws. The holes for these screws are countersunk and filled with putty. Four coats of black shellac are applied to each frame. The weights of the different arms completed (including fixed and micrometer points) are shown in the following table:

Capacity of arm.	Weight.	Capacity of arm.	Weight.
Inches.	*Pounds.*	*Inches.*	*Pounds.*
0 to 5	3½	25 to 30	9
5 10	4	30 35	10
10 15	6½	35 40	11
15 20	7	40 45	13
20 25	8	45 50	14

The following data, from records of testing department, show, comparatively, stiffness of wooden and steel arms.

Deflection of arms when suspended at the middle and loaded at the ends of the arms before lagging.

Loads.	Deflections.		
	Steel arm 55 to 60 inches, weight 15 pounds 12½ ounces.	Steel arm 65 to 70 inches, weight 21 pounds 13 ounces.	Wooden arms 65 to 70 inches, weight 13 pounds 8 ounces.
Pounds.	*Inch.*	*Inch.*	*Inch.*
0.	0	0	0
.25	.0009	.0010	.0005
.50	.0018	.0022	.0009
.75	.0027	.0032	.0011
1.00	.0041	.0043	.0014
1.25	.0052	.0053	.0018
1.50	.0062	.0064	.0026
1.75	.0071	.0074	.0026
2.00	.0085	.0089	.0028
2.25	.0096	.0097	.0030
2.50	.0105	.0107	.0034
2.75	.0113	.0117	.0038
3.00	.0123	.0123	.0041
3.25	.0133	.0142	.0045
3.50	.0143	.0150	.0048
3.75	.0154	.0158	.0051
4.00	.0163	.0172	.0055
4.25	.0175	.0178	.0059
4.50	.0184	.0190	.0063
4.75	.0196	.0200	.0065
5.00	.0207	.0211	.0069
0	0	0	0

Weight of steel arms after lagging, 55 to 60 inches, 21 pounds 14 ounces; 65 to 70 inches, 29 pounds 12½ ounces. Weight of wooden arm does not include sockets and joints.

Deflection of arms when lying down; one-half of arm supported, other end unsupported.

[Deflections taken at end of unsupported end.]

Load at unsupported end.	Deflections.					
	Steel arm 55 to 60 inches.		Steel arm 65 to 70 inches.		Wooden arm 65 to 70 inches.	
	Before lagging.	After lagging.	Before lagging.	After lagging.	Without web-plate.	Web plate between lower stringers.
Grains.	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*	*Inch.*
0	0	0	0	0	0	0
100	.0092	.0024	.0126	.0021	.0028	.0027
200	.0189	.0048	.0253	.0045	.0058	.0053
300	.0295	.0070	.0382	.0069	.0085	.0080
600	.0604	.0133	.0764	.0129	.0173	.0157
1,000	.0995	.0224	.1284	.0227	.0291	.0247

Deflection of arms caused by their own weight.

Position of arm.	Steel arm 55 to 60 inches.		Steel arm 65 to 70 inches.		Wooden arm 65 to 70 inches.
	Before lagging.	After lagging.	Before lagging.	After lagging.	
	Inch.	*Inch.*	*Inch.*	*Inch.*	*Inch.*
Suspended	0	0	0	0	0
Lying down.....	.0088	.0043	.0073	.0042	.0008

(*b*) *Frame socket.*

This is a brass casting with rectangular cavity, into which foot of frame upright fits, and with projecting flange for attachment of ball socket. The foot of upright is slightly trimmed down to allow it to enter socket with a good fit, and the metal is brought to a bearing against the shoulder as the end of upright reaches bottom of cavity. To make this connection more rigid and durable the end of upright is covered with white lead when inserted into cavity, and a quarter-inch bolt, secured by nut on inside, passes through metal and wood.

(*c*) *Ball socket.*

This is a brass casting in two parts. The parts are joined to each other and to flange of frame socket and inclose ball, as shown. The clamp screw at bottom permits securing of ball in any position. In addition to screw, dowel pieces are used in joining ball socket to flange of frame socket. These parts are interchangeable.

(*d*) *Ball.*

This is a brass casting turned, bored, and planed to shape shown in drawing. A hole 0.5 inch in diameter is bored through ball for about half its thickness between faces; for balance of thickness the hole is

larger and threaded to receive a split clamp nut with milled head and tapered end. The interior diameter of this nut is 0.5 inch. The cylindrical parts of fixed and micrometer points are made to fit in the 0.5-inch hole. When point is passed through nut and ball and the nut is screwed up until split and tapered end is brought to a bearing at tapered surface joining two diameters in ball a rigid connection of point and ball is secured.

(e) *Measuring points.*

These are of the ordinary type. The least reading is 0.0005 inch, but a difference of 0.0001 inch can be readily detected, and, with care, the average operator should keep errors due to personal equation within 0.0002 inch. For a single setting (supposed at 0) the micrometer has a range of 0.25 inch.

II. APPURTENANCES.

(a) *Adjusting rods and pipes.*

Pl. IV.

These are of steel and are used in adjusting ball and socket joint so that when fixed and micrometer points are in position their axes shall be in same right line. The means for extending rods to adjust length to capacity of arms and for clamping them when extended are made sufficiently clear by the drawing.

(b) *Suspension apparatus.*

(Pls. I and II.)

A hollow brass pipe (a piece of rolled brass tubing 1.5 inches exterior diameter and 0.125 inch thick) is supported in bearings and adjusted to a position parallel to axis of piece to be measured, and at a height above it such that when arms are suspended by spring, as shown in Pl. I, the fixed measuring point will be in horizontal plane containing diameters to be measured. When it is desired to measure successive diameters and to check measurements by repetitions it is recommended that a chalk line be drawn and points for measurement indicated thereon. The supports for this pipe consist of saddles (brass castings) secured in position by leather straps passing around the gun. To each saddle is secured a short piece of brass tubing about 22 inches long, split at top and provided with clamp screw. Another piece of tubing, 24 inches long, telescopes into this and has secured to its upper end the socket and clamp for horizontal tube first mentioned. The leather straps are in sections, so that total length may be readily adjusted to circumference of piece. The method of tightening and securing strap—that in ordinary use for horse saddle—is shown in the sectional view, Pl. I. The projecting rib on saddle casting and screw afford an adjustable third point of support which adds to rigidity of saddle when in position and permits, also, an adjustment of inclination of telescoping pipes by which they can be made perpendicular to axis of piece. Their usual position is vertical.

The construction and general use of suspension apparatus is shown so clearly by drawing that a detailed description is deemed unnecessary.

The endless cord and sliding saddle on the tube permit easy movement of arms from one position to another.

Three springs of different lengths are supplied with each set of caliper arms. These, in connection with the adjustment for height permitted by telescoping brass tubes, will enable the operator to readily suspend the calipers at the proper height. The pipe supporting calipers is in two sections, each 6 feet long, with convenient screw joint in center. If the longitudinal distance over which measurements are desired is greater than 12 feet it will be necessary to shift the saddles. This is done quickly and easily. The weights of principal parts of suspension apparatus are as follows: Saddle, strap, and telescoping tubes, 27 pounds; horizontal tube (2 sections), 26 pounds. This is the first apparatus constructed. From experience gained, minor improvements may be introduced in future and the whole apparatus made lighter.

(c) *Electric circuit and bell for contacts.*

These are not essential, but will be of great assistance where extreme accuracy is desired, and especially where the operator, from nervousness or other causes, is unable to rely upon his sense of touch. They assist the best of experts in making uniform contacts. A small dry battery is compactly stored in a neat wooden box, on the outside of which are terminal binding posts and a small bell. Flexible insulated wire cords, of convenient lengths, lead from these terminals to the small binding posts shown in Pl. III. The points are insulated by wooden frames, and the operator moves the micrometer point in and out until two positions are found as near to each other as possible, the outer producing no sound, and the inner causing the bell to ring as the point is gently moved in a vertical plane over extremity of diameter to be measured.

III. INSTRUCTIONS FOR USE OF CALIPERS AND APPURTENANCES.

(a) *To adjust ball and set the calipers.*

Knowing approximately the diameter to be measured, select the proper arm and lay it on some convenient horizontal surface. Select one adjusting rod or both rods and a pipe, according to capacity of arm. and see that the binding screw for ball socket and the clamp nut inside of ball are loose. Insert a rod from outside inward through each clamp nut and ball and push the rod through until their inner ends have entered at least 6 inches into the pipe. Clamp the rods in balls and in pipe. Clamp the balls firmly in their sockets. Unclamp rods and withdraw them, being careful to grasp them near sockets and to apply all pressure in the direction of their axes. A cross stress, especially with the leverage given by holding rod at its end, would endanger adjustment of balls. The balls should not require readjustment for some time. Insert measuring points with same care and clamp them. Suspend the arm for setting points to standard diameter. For this purpose the suspension apparatus could be set up on floor, but it will be more convenient to place on the wall a small hook, about 6 feet above floor and projecting about a foot from the wall.

The points could be set without suspending arm, but for accurate work the setting should be under the conditions of subsequent measurement. The main errrors thus avoided are those due to deflections of arm under its own weight.

The usual method of setting points is as follows: Set the micrometer at 0 and push the points bodily in or out of sockets until their ends are in rough contact with standard. Clamp both points in sockets and make finer adjustment by turning milled head on fixed point. The bell should be used in this adjustment if to be used in measuring. If fine adjustment be made by turning micrometer point, the reading when "set" is noted and a corresponding correction applied to subsequent readings.

For special measurements, great care should be taken to avoid errors due to variations in temperature of standard and of calipers. A few minutes' handling with bare hands will produce marked variations. Thick pieces of felting or some other nonconducting material should be used in handling the standard, and the wooden frame of arms, not the metal socket, should be grasped in steadying and moving for contact. A piece of felting tied around head of micrometer point is advisable.

(b) To assemble and adjust suspension apparatus.

Place saddles in proper positions and strap them securely. They are easily placed by the eye, so that the horizontal pipe will lie with sufficient accuracy in vertical plane containing axis of piece. Before lashing strap, see that all slack on opposite side of gun is taken up. If lashing pulls saddle toward operator, inclining upright tubes in a plane perpendicular to axis of piece, make allowance for this by taking up slack as directed, and by first giving an opposite inclination to tubes. Draw on the free end of strap until the tubes are brought back to vertical. After a little practice it will be an easy matter to quickly secure saddles in position. The pipe, in one or two sections, is then handed to the assistant, who secures it in its sockets alternately. To prevent binding, the pipe should be passed through socket gently and held in direct prolongation of socket. When in position, with holes in end vertical, it is clamped. The small saddle is now placed on pipe, its wire hook sprung into place, and the suspension spring with calipers attached hooked into wire. The two ends of pipe are raised or lowered until fixed measuring point reaches chalk line and then clamped. The ends of traversing cord are passed from bottom upward through holes in end of pipe and attached to hooks of small saddle. The arms are now ready for use. A screw plug, with holes in it for passage of cord, is furnished to close open end when only one section of pipe is used.

All important measurements should be checked by one or more repetitions. Where successive diameters are required it is recommended, as previously stated, that a chalk line be drawn, with ordinary straight edge, to represent intersection of plane of measured diameters with exterior surface of piece, and that points separated by desired distances be marked on this line. The distance of one of these points from any fixed section of piece will determine location of measured diameters for record.

The photograph submitted herewith shows the apparatus mounted on the Woodbridge wire-wound gun, which is in the lathe. With uniform pressure the assistant holds the fixed point in contact at marked points, and as measurements are completed traverses the arms by means of cord to next point.

Suspension Apparatus.

Fig. 1.

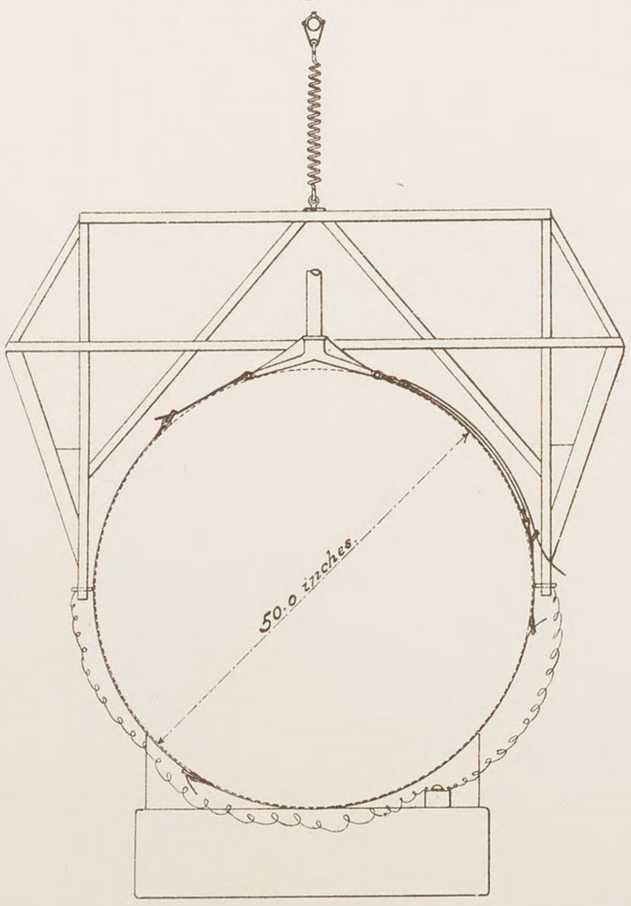
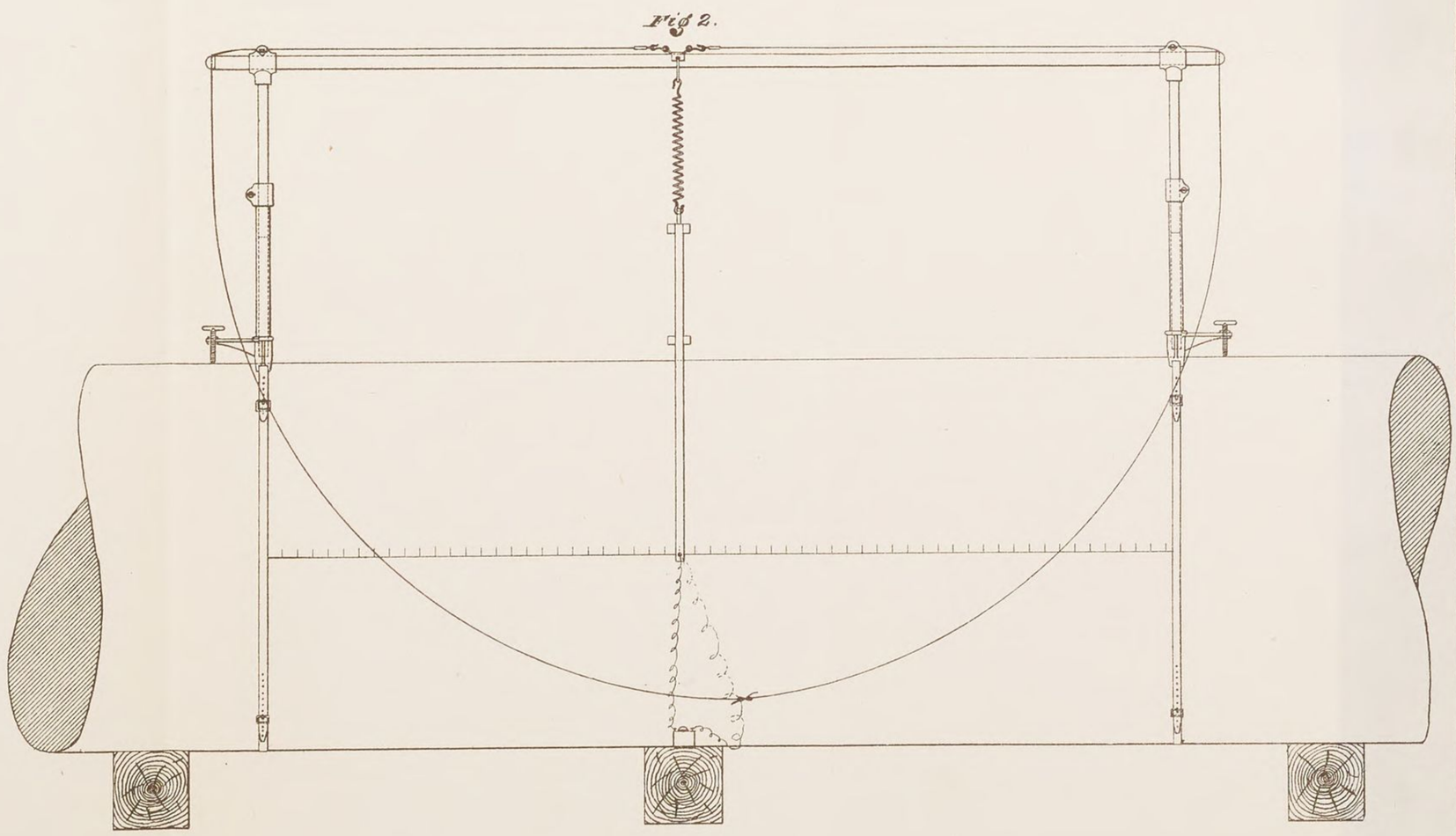
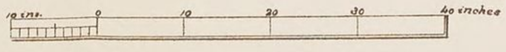


Fig 2.





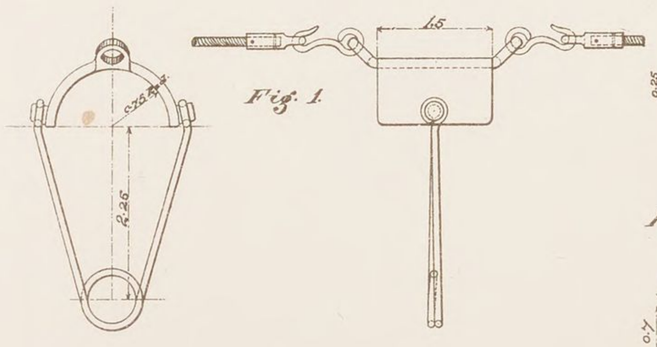
WATERTOWN ARSENAL JUNE 4th 1892.

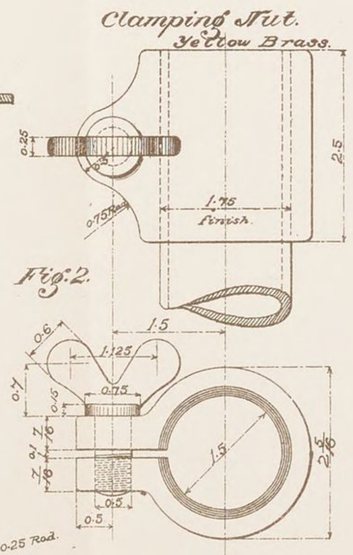
Appendix 49, 1892.

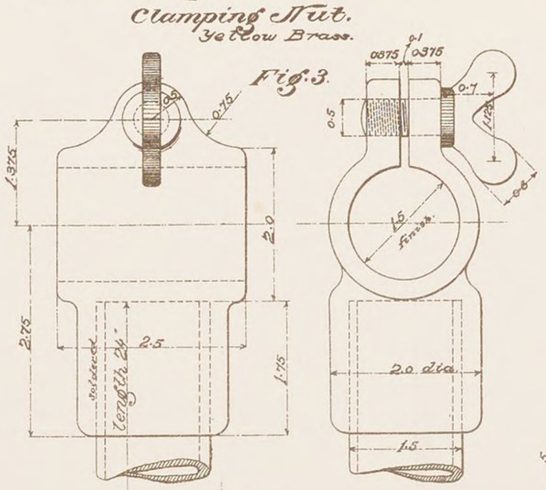
J. M. Ruhlen
MAJOR ORDNANCE DEPT. U.S.A.
COMMANDING.

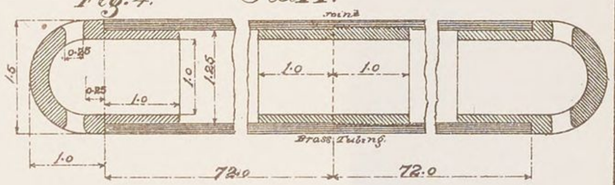
Ord 52 2

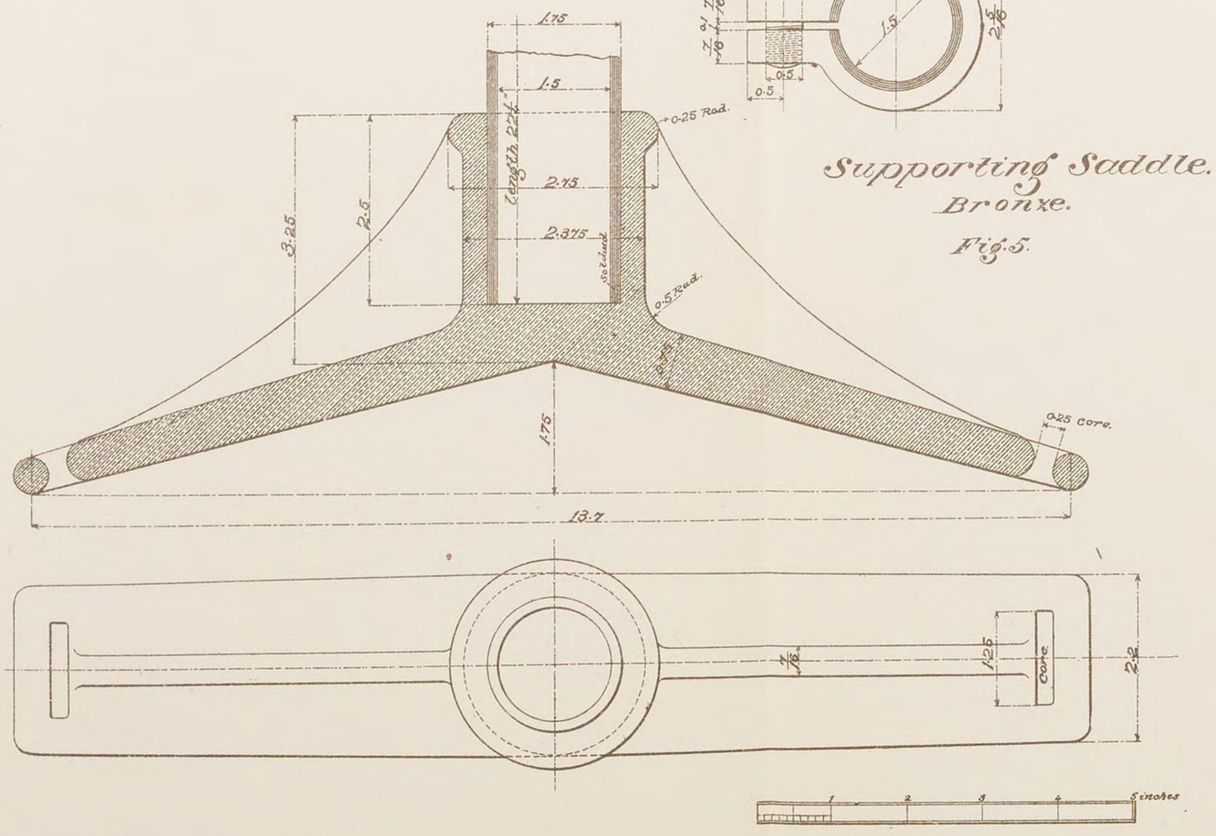
Details of Suspension Apparatus.



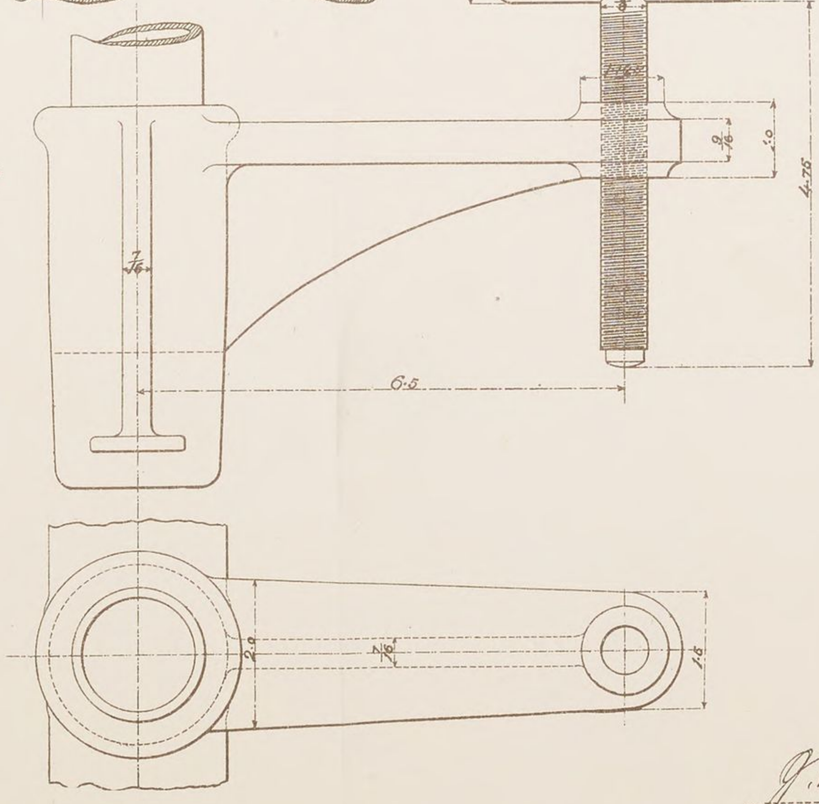






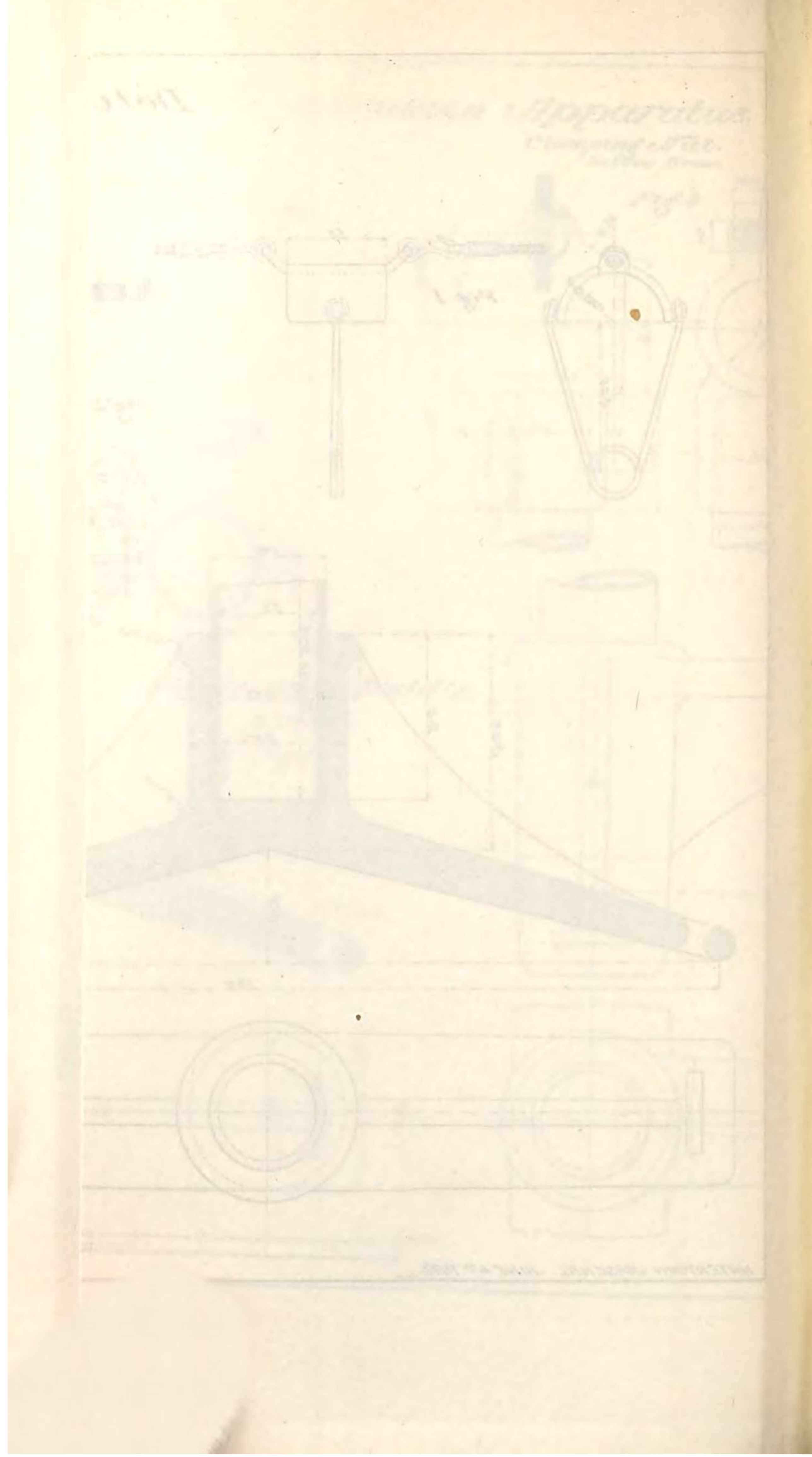


Supporting Saddle.
Bronze.
Fig. 5.



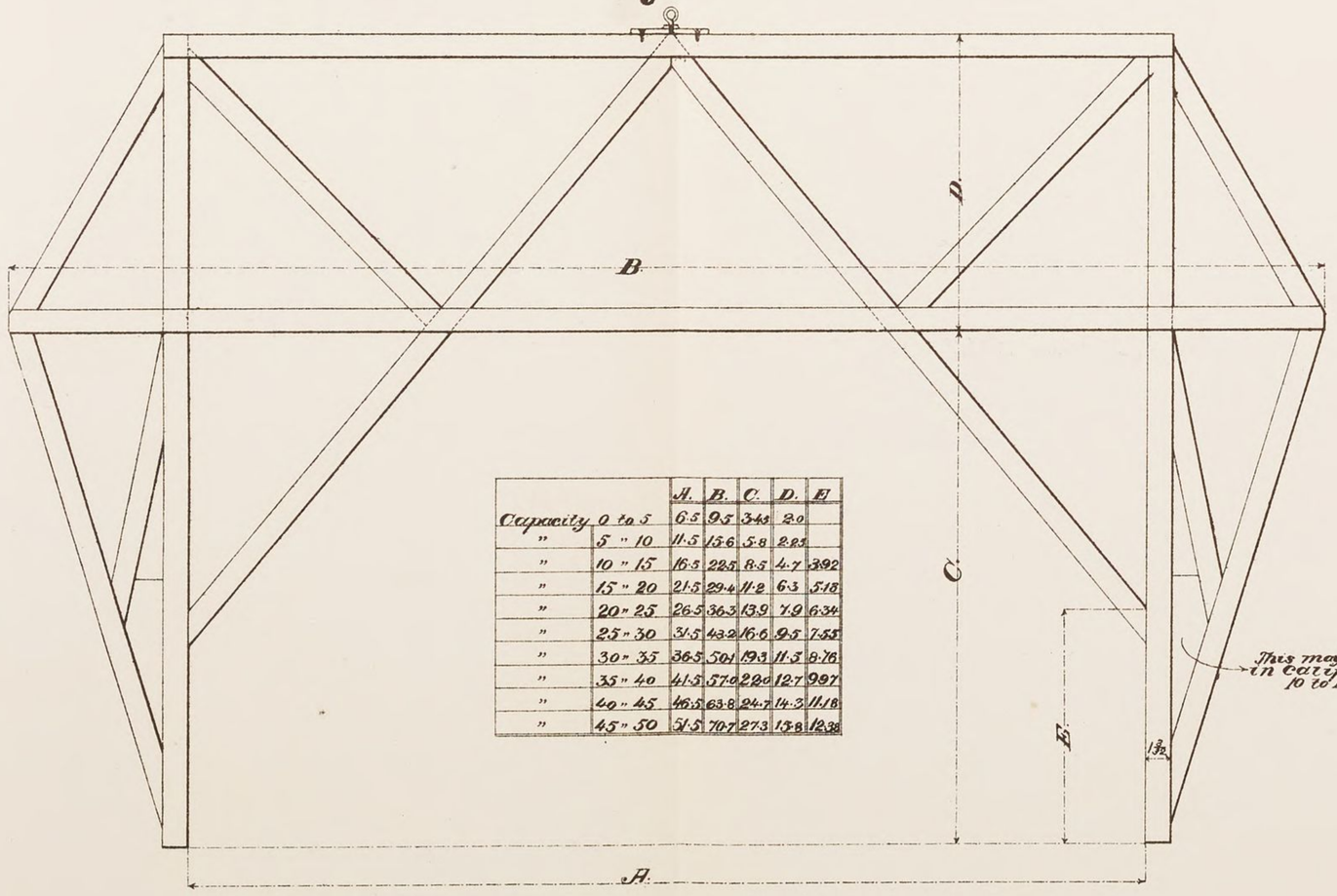
J. W. Reilly,
Major Ordnance Dept. U.S.A.
Commanding.

WATERTOWN ARSENAL JUNE 4TH 1892.



Wooden Caliper Arm.

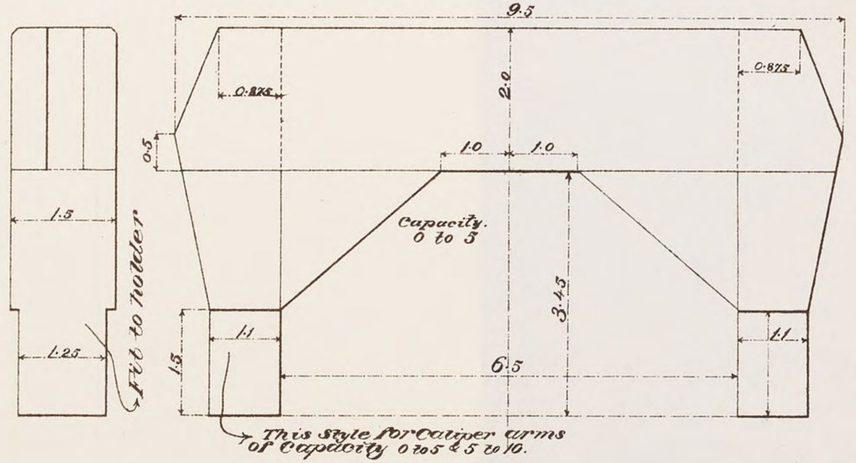
Fig. 1



	A.	B.	C.	D.	E.
Capacity 0 to 5	6·5	9·5	3·43	2·0	
" 5 " 10	11·5	15·6	5·8	2·25	
" 10 " 15	16·5	22·5	8·5	4·7	3·92
" 15 " 20	21·5	29·4	11·2	6·3	5·18
" 20 " 25	26·5	36·3	13·9	7·9	6·34
" 25 " 30	31·5	43·2	16·6	9·5	7·55
" 30 " 35	36·5	50·1	19·3	11·3	8·76
" 35 " 40	41·5	57·0	22·0	12·7	9·97
" 40 " 45	46·5	63·8	24·7	14·3	11·18
" 45 " 50	51·5	70·7	27·3	13·8	12·38

This may be left out in caliper arms of capacity 10 to 15 & 15 to 20.

Fig. 2.



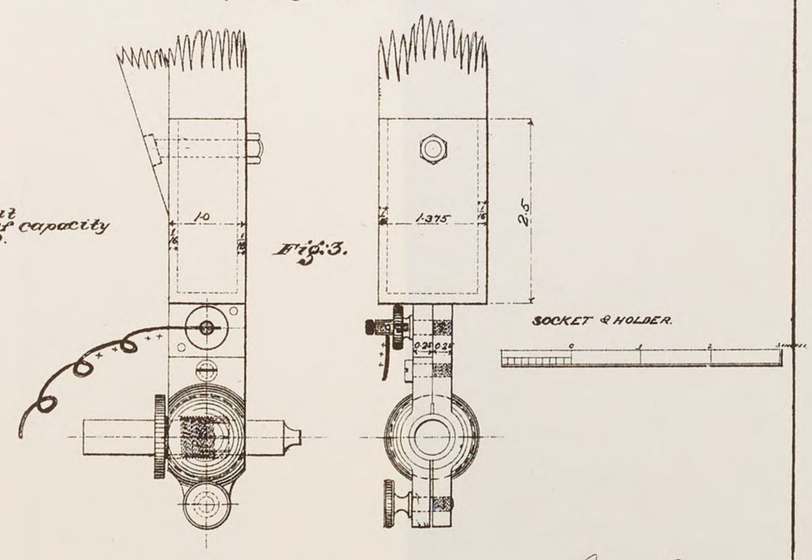


Fig. 3.

WATERTOWN ARSENAL JUNE 4TH 1892.

Appendix 49, 1892.

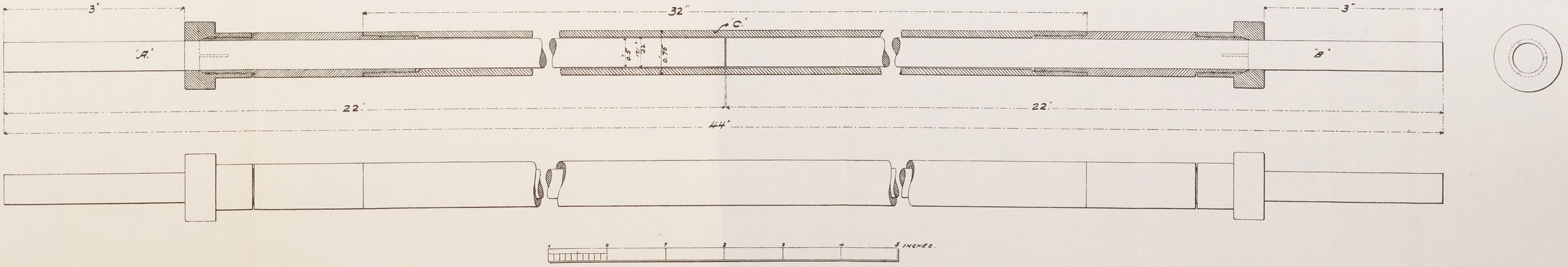
J. M. Reilly
MAJOR ORDNANCE DEPT U.S.A.
COMMANDING.

Ord 52 2

Adjustable Rod for Wooden Caliper Arm.

PROPOSED BY COLONEL D.W. FLAGLER.

ONE ROD "A" FOR CHORDS 0" TO 20"
RODS "A" & "B" & PIPE "C" 12" LONG FOR CHORDS 20 TO 40"
" "A" & "B" & " "C" 32" " " " 40 " 76"



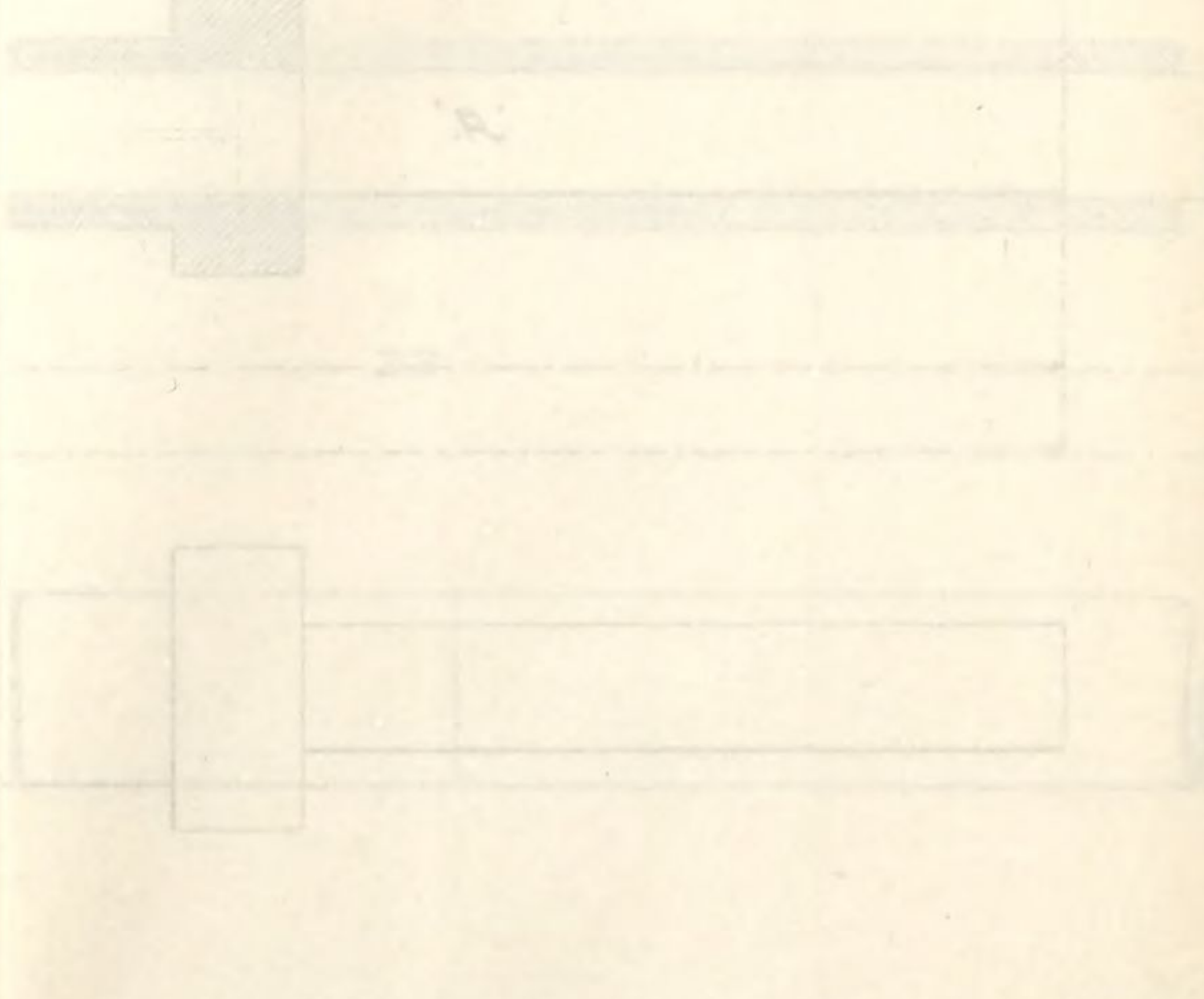
D.W. Flagler

COLONEL ORDNANCE DEPT. U.S.A.
COMMANDING

WATERTOWN ARSENAL JAN. 29TH 1891

Appendix 49, 1892.

Ord 52 2



APPENDIX 50.

REPORT OF BOARD ON INSPECTING INSTRUMENTS.

(19 plates.)

WATERVLIET ARSENAL,
West Troy, N. Y., July 26, 1892.

SIR: Complying with your instructions of the 13th ultimo, the Board on Inspecting Instruments has the honor to submit the following final report:

The board was convened in compliance with your instructions of April 30, 1890, by post orders No. 16, dated May 3, 1890, with the following members, viz: Capt. Charles Shaler, Ordnance Department; Capt. Ira MacNutt, Ordnance Department; Lieut. L. L. Bruff, Ordnance Department. James E. Howard, civil engineer, was, by direction of the Chief of Ordnance, associated with the board for the consideration of instruments, and has attended meetings of the board for that purpose. He has rendered the board much valuable assistance.

On December 17, 1890, Capt. Charles Shaler was relieved from the duty and Capt. C. C. Morrison was detailed as a member in his stead.

On January 6, 1892, Capt. W. B. Gordon and Lieut. D. A. Howard were detailed as members in the place of Capt. Ira MacNutt and Lieut. L. L. Bruff, and on May 3, 1892, Lieut. F. E. Hobbs was added to the board as a member.

The following instruments have been devised or passed upon by the board, viz: Caliper arms and points, caliper arm saddle, measuring points for interior diameters, micrometer for surface lengths, step gauge and templets, chamber length gauge, interior length gauge.

The star gauge has been modified and a shop comparator is being manufactured in accordance with the recommendations of the board.

The description of the various instruments as adopted after trial and some modification is as follows, viz:

1. CALIPER ARMS.

(Pls. I and II.)

Description.—The caliper arm frames are made of Bessemer or other merchant steel, the dimensions of a set of arms for guns up to 16-inch caliber being as shown on Pl. I. The frames are lagged with wood, as shown on Pl. II, two layers being applied on each side with grain crossing and the pieces breaking joints. The fixed and measuring or micrometer points used with the arms are shown on Pl. II. Their construction is obvious from the drawing. The fixed point is capable of a small longitudinal motion by turning the rear screw; it is clamped in

position by the nut at forward end, the sleeve being split to allow this clamping. Fig. 3 shows the fixed point required for the small diameters of the lips of hoops. The measuring point has a similar modification. The hook shown on Pl. II is for suspension of those arms which are too heavy for use as hand calipers. A saddle, to be described further on, is used to suspend these heavy arms.

Method of use.—Each point has a travel of about 2½ inches, giving to each arm a total capacity of 5 inches. To measure any given diameter, say 5.798 inches, the measuring point is adjusted to zero of the micrometer scale; a measuring rod is set to 5.790 inches; the fixed and movable points are then placed in the proper arm, in their sockets, and made to project inside about equally, and as nearly as convenient to the size of the rod 5.790 inches; the two points are then clamped in their sockets in the arms; the distance between the points is made exactly 5.790 inches by adjusting the fixed point, which is then clamped in position by the clamp nut at its forward end; the arm with its points is then suspended, and the diameters measured by making contact with the micrometer point. The set should be tested during the progress of the work.

2. CALIPER ARM SADDLE.

(Pl. III.)

Description.—This support for heavy caliper arms is designed to be independent of any appliances exterior to the work to be measured, so that the operation can take place in any position or any place; it consists of a base, A, of steel, the two feet A^1 being of brass. E E are fastenings for a leather strap. The cross-section of the base is shown on the right of the tracing. The rack B slides through the base A. It carries at one extremity the upright hollow rod J and this rod is secured to the rack by the tie-rod and the support at G. Inside of the rod J slides a smaller rod I. By unclamping the thumb-screw on M, the rod I will slide freely through the collar M, and thus give quick adjustments in height. By clamping M the smaller adjustments in height can be obtained by the tangent screw N. Q is an adjustable rod which supports the spring from which the caliper arm is suspended. It is clamped in any position by the set screw P. D is the milled head that drives the pinion which moves the rack B; F is a spirit level. A roller, R, gives a rest for the extremity of the rack B when extended in working. This roller is adjusted to the proper height by means of the nut *a*. A second movable rod, I^1, is required to give sufficient height for the larger arms. The leather strap is in two pieces. The smaller piece, attached permanently to the left lug of the saddle, is 10 inches long and carries the buckle. The larger piece, which is attached permanently to the right lug of the saddle, is 4 feet long. A hole is made in the end of the 4-foot strap, and two extra straps, each 4 feet long, provided with an ordinary buckle at one end, are furnished for large guns. The second strap is buckled on to the permanent 4-foot strap with the ordinary buckle. The two extra straps will give sufficient length to encircle the outside diameter of the 12-inch gun. For a diameter of 70 inches three straps more will be needed, each 4 feet long, making a total of five extra straps each 4 feet long.

Method of use.—The leather strap being attached at E E to the base, the latter is mounted upon the work to be measured, the feet A^1 A^1

resting on the exterior surface. Having leveled the base with the spirit level, the strap is drawn tight and held by the tongueless buckle shown in the tracing. The caliper arm is then suspended by its hook and spring, the spring being attached to the rod Q of the supporting saddle. The height of the arm is then adjusted by raising or lowering the rod I, and the adjustment parallel to the axis is obtained by movement of the rod Q. The upper face of the rack B is graduated into inches, the zero being marked when the rack is in its extreme position as in the drawing. The rack B is now moved forward by the pinion D, and measurements made every inch of length. The length of the rack being 12 inches, it will be necessary to change the position of the saddle after measuring this length. This is done by loosening the leather strap, pushing the saddle forward to its new position, and again tightening the strap.

3. MEASURING POINTS FOR INTERIOR DIAMETERS.

(Pls. IV and V.)

Description.—(*a*) For measuring diameters from 2 inches to 10 inches. These are shown on Pl. IV. The points are made of steel, and are so arranged that one micrometer screw is used for all the points. The different lengths are obtained in each case by screwing the fixed points shown in the plate into the rear ends of the thimble of the micrometer screw. For lengths up to about 4.50 inches the points shown on the right-hand side of the plate are used. These fixed points when screwed into the micrometer thimble and set at any given length are clamped in place by the locking nut shown in the plate. Beyond 4.50 inches the points shown on the left-hand side of the plate are used. These differ from the others in having an extension piece screwed into the micrometer thimble, and this extension piece carries the thread into which the fixed points are screwed. This extension piece carries a clamp and clamp screw, which locks the fixed point in any position. Two small holders of wood are shown in the plate. They are intended to cover the points and protect them from expansion by the heat of the hand as soon as the point is long enough to project beyond the ends of the holder.

(*b*) For measuring diameters above 10 inches. These are shown in Pl. V. As before, only one micrometer screw is used, and is shown in Fig. 1. Only one fixed point is used and is shown in Fig. 2. The rear end of the fixed point is threaded, and into this screws the adjustable point shown in Fig. 2. The point is clamped by the clamp screw, the threaded end being split. The front end of the fixed point is also threaded for the insertion of either of the extension pieces shown in Figs. 4 and 5. It is also graduated. Fig. 3 shows the wooden holder which is intended to carry the points for all diameters. At its ends are the two ferrules which are screwed on to the holder and are provided with clamp screws for the points in the ferrule. The wooden holders with ferrules increase in length by increments of 5 inches from that shown on the drawing up to the greatest interior diameter to be measured. The first holder is 7 inches long, the second 12 inches long, and so on.

Method of use.—Having selected the holder of proper length for the work to be done, place the fixed and measuring points in the ferrules, clamp the measuring point and set the zeros of micrometer and index together. Set the fixed point accurately by the scale to the nearest

one-hundredth and use the micrometer point for differences. Until the point attains the temperature of the hand, check the accuracy of the set every few inches. Check the accuracy of the set at least once during the measurement of a hoop in addition to the check which should always be made at the commencement and end of the work on a hoop.

4. MICROMETER FOR SURFACE LENGTHS.

(Pl. VI.)

Description.—This instrument is used for measuring the distance between two given points on the exterior surface of a jacket or hoop before and after shrinkage, thus determining the change of length due to shrinkage. It consists of a main body or beam, D, which carries a slide, E, and to this slide are attached the support C for the micrometer point A, and also the conical point G. This slide E is locked to D by the screw N. The fixed point B is carried by the support L, and this support is fixed to the body D. At the right hand end of the body D is the screw M, which locks the extension bar J to the body. There are three of these bars, by the use of which lengths up to 40 inches can be measured. Along the extension bar J slides a point H, which may be clamped along this bar at intervals of 0.20 inch by means of the clamp screw attached to it, which enters correspondingly holes in the extension bar. The fixed and micrometer points B and A are adjustable in their supports. Two reference bars are used, one measuring up to 20 inches and the other from 20 to 40 inches. The small screws are used for adjusting the gibs. A guide block and center punch are used to make the holes in the surface of the hoop into which the points G and H are inserted. These are shown in the plate. The guide block is to insure that the punch shall move at right angles to an element of the hoop. The angle of the conical points is 60°, that of the punch is about 65°.

Method of use.—Having made the holes with the center punch in the surface of the hoop to be measured, their distance apart can be measured approximately. Suppose this distance to be 18.42 inches. Move the point H along the extension bar till it will enter the 18-inch hole on the reference bar, and clamp it in position. Then move the point G till it enters the $\frac{1}{2}$-inch division on the reference bar and clamp it. Fix the micrometer at zero and adjust the points A and B till they are in contact. The instrument now reads exactly 18.50 inches. The micrometer is graduated so as to read both ways from zero. Place the instrument on the hoop to be measured, the point H in one hole and the point G in the other. Make contact with the fixed point B by the micrometer A. The micrometer reading subtracted from 18.50 inches will give the length between points. After shrinkage set the instrument on the reference bar, as before, to 18.50 inches. Then set it in the points on the hoop, make contact, and take the reading as before. The difference of the readings before and after shrinkage will give the change of length due to shrinkage.

5. STEP GAUGE.

(Pls. VII and VIII.)

Description.—This instrument, shown on Pl. VII, is used for measuring the lengths of shoulders and steps in hoops, etc. It consists of a handle and body *a*, at right angles to which slides a blade, *b*. These blades are intended to be of three lengths, measuring from 5 inches to

43.50 inches. The blade is graduated as in the Brown and Sharpe scale, and the instrument provided with a vernier reading to thousandths. Templets are furnished to fit the various shoulders (those required for an 8-inch B. L. rifle, model 1888, are shown on Pl. VIII).

Method of use.—To measure lengths of steps in hoops the templet corresponding to the shoulder board is attached to the blade, as at *c*, by the two screws *d d*. The shoulder on the templets is at a distance of 1 or 2 inches, as the case may be, from the tangent line of the curves which form the shoulder. The shoulder on the templet is set firmly against the front edge of the blade at E before the screws are clamped. The body *a* is held firmly against the faced end of the hoop and contact is made with the shoulder by sliding the blade *b* through its socket. The given distance on the templet is then added to the reading.

6. SHOP COMPARATOR.

(Pls. IX and X.)

Description.—A general view of the instrument is given in Pl. IX. The parts of the instrument are: (1) The bed or body; (2) the leveling screws; (3) the supports; (4) the fixed head; (5) the sliding head; (6) the auxiliary sliding head; (7) the standard bar; (8) the microscope and mounting; (9) the scribing attachment; (10) the adjustable points and various clamping and adjusting screws, spring gibs, etc. The main part of the instrument consists of a bed or body of cast iron, which is shown in Pls. IX and X. This bed rests upon two cast-iron supports *a a* and is leveled by three screws. Two of these screws are carried by one support and the third by the second support. By this means the bed can be leveled in two directions at right angles. The upper part of the bed has a recess *c*, in which the standard graduated bar is placed, and is held in place and prevented from slipping by set screw *f*. The projecting rib *d* carries the fixed, sliding, and auxiliary sliding heads, and guides the moving parts. The projecting table *e* is intended to support templets, etc., when lines are to be laid off on them by the scribing attachment.

The fixed head.—As its name indicates, this is fixed on the bed at any point by means of the clamp screw *g* and the spring gib, and carries the fixed measuring point in the support *h*.

The sliding head.—This carries the movable measuring point, the microscope and its mounting, and the scribing attachment when in use. It is shown in Pl. X. The support for the movable measuring point is shown at *k;* the microscope mounting at *l* (Pl. X) and at *n* (Pl. IX). The mounting is composed of a socket mounted on a gibbed slide and adjusted vertically by a tangent screw. This vertical slide is carried on a horizontal slide. Horizontal adjustment is obtained by two tangent screws carried by the sliding head. These screws bear against a stud on the horizontal slide.

The auxiliary sliding head.—This is shown at P. It slides with the sliding head, is clamped in any position on the bed by its clamp screw, and is connected to the sliding head proper by a tangent screw, and gives small adjustments for the sliding head.

The standard bar.—This rests in the recess *c* of the bed. It is intended to be 70 inches long and accurately graduated.

The microscope.—This is shown in the general view. It is intended to be of such power as to readily read to 0.0005 inch.

The scribing attachment.—This is intended to be used for laying out templets accurately for lengths and for verifying them when laid out. It is shown in Pl. IX. It is attached to the upper surface of the sliding head by two screws, and projects over the table *e*. At right angles to the bed slides an arm, and this carries a vertical sliding piece, to the lower end of which a scribing point is attached.

The adjustable points.—These are shown in their supports at *h* and *k*. They are made adjustable in order to correct for wear.

Method of use.—The graduated bar being in its recess and the points *h* and *k* being in contact, the bar and microscope are adjusted so that the zero line of the eye-piece of the microscope coincides with the zero of the bar. To lay off a given length, the fixed head being clamped in place, move the sliding and auxiliary sliding heads till the microscope stands over the nearest division of the standard bar; then clamp the auxiliary sliding head and move the sliding head to the right or left till the required thousandths are obtained. The distance between the points will be the required length. The lengths for the scribing attachment are similarly obtained.

7. CHAMBER LENGTH GAUGE.

(Pl. XI.)

Description.—This instrument is used to determine the length, etc., of the powder chamber by measuring the distance from the end of tube (or rear face of base ring depending on the caliber of the gun) to a given place on the front slope of the chamber about where the band of the projectile in place will rest and near the beginning of rifling. It consists of a hollow jointed staff adapted to receive at one end the several gauge rings shown on the drawing. These gauge rings (one for each caliber) are coned on the exterior surface and are of such diameter as to accurately fit the front slope of the chamber. The staff also carries a sliding hub which serves, through the medium of an attached straightedge, to mark the length. This sliding hub can be clamped at any point on the staff by a clamp screw. It bears at one end a permanently fixed pin, on which the straightedges are mounted, and at the other end a scale for reading variations in length. The staff itself has inscribed on it the proper lengths for the various calibers, constituting the zero of the scale. The first section of the staff, with handle attached, is used for the smaller calibers, and the other sections are added as may be necessary. The star gauge staff support should be used for seacoast guns to support and center the staff.

Method of use.—Make the staff of proper length. Attach the proper gauge ring to the end of the staff and the proper straightedge to the sliding hub. Attach the staff support if necessary. Press the gauge ring firmly into the slope of chamber and bring the straightedge against the end of tube or base ring. Clamp the hub and read the variation in length from the required length.

8. INTERIOR LENGTH GUAGE.

(Pl. XII.)

Description.—This gauge is designed to facilitate the measurement of the interior diameters of hoops. It consists of a strip of brass with counter-sunk holes one inch apart, held in place by a turn of the strap at right angles at one end and by a clamp and screw at the other.

Method of use.—Pull the gauge firmly against one end of the hoop and clamp it at the other end. Insert the fixed point of the measuring rod in the several countersunk holes in succession and determine the diameter. Both hands will be free for the work of measurement.

9. STAR GAUGE.

(Pls. XIII, XIV, XV, XVI, XVII, and XVIII.)

Description, as recommended for future manufacture.—The principal parts of the instrument are the head, the staff, and the handle. The accessories required in the use of the instrument are the interior rest, the exterior rest, the muzzle rest, the rifle guide, the points for head (of various lengths), and the ring gauges.

The head is arranged to revolve while measuring rifled bores, so that the scale may remain constantly in view and be easily read. The head is clamped to prevent rotation while measuring smooth bores.

The staff is a simple brass tube to protect the rod connecting the cone of the head with the micrometer handle. It is graduated into inches.

The handle consists of a micrometer head which screws into the handle casing with a thread of 5 per inch, right hand. In the casing, and next to the micrometer head, is a small sleeve which has a screw thread cut in its forward end for securing it to the square rod which carries the cone. In its other end is a screw thread into which the end of the micrometer head engages with a thread of 8 per inch, left hand. The sleeve is keyed to the casing so as to allow it a longitudinal motion only. It is thus seen that one revolution of the head carries it into or out of the casing one-fifth of an inch, while the sleeve moves one-eighth of an inch from or toward the head in the same time. This gives the sleeve, in one revolution, a movement of $\frac{1}{5}'' + \frac{1}{8}'' = \frac{325}{1000}''$ in the same direction as the head. The cone is made of such a pitch that $\frac{1}{50}$ of a revolution of the micrometer corresponds to a distance of $\frac{1}{1000}$ inch in the motion of the measuring points, and the head is graduated accordingly.

The casing is clamped in a short brass tube which completes the handle, and this tube screws on the staff. The only modifications of the handle, as shown on the drawings (Pl. XIII and XIV), are to make the knurled portion of the index and locking rings each 1 inch long, and to omit the small clamp screw which fastens the sleeve to the square rod. The sleeve and square rod are screwed together when in use, and are both prevented from turning; they can not separate, and no clamp is necessary.

The interior rest now in use here is entirely satisfactory. It is simple in construction, not too heavy, and is very convenient to use. The details are evident from the drawing, Pl. XV.

The exterior rest consists of a small wooden stand supporting two vertical guides. Between the guides is mounted a roller bearing on which the star-gauge staff rests. The roller is adjustable to the height of the axis of the gun. The construction is evident from the drawing, Pl. XVI.

The muzzle rest consists (Pl. XVII) of a steel bar carrying two bronze slides, the slides being moved in opposite directions by means of a right and left hand screw attached to the steel bar. Each slide carries two steel studs, which are intended to be set out against the bore of the piece to be measured by simply turning the crank on the end of the

screw. The studs are made slightly conical, so that the free ends will engage first and prevent their being wedged out of the bore by any probable springing of the instrument in setting the points up tightly by means of the screw. The studs are at the corners of a rectangle whose diagonals intersect on the axis of the piece to be measured. No graduations are necessary, as the rest is constructed so as to center itself automatically.

The rifle guide is a simple attachment to the measuring point, as shown on Pl. XVIII. It follows the groove very well, and is simple and convenient to use. The head of the star gauge should be made of such diameter that this attachment may be used in the 8-inch gun.

The ring gauges are simple iron castings accurately bored to given diameters.

Method of use.—Assemble the head, staff, and micrometer handle. Turn the zero of the micrometer upwards. Clamp the steel clamp. Unclamp the brass clamp. Push the micrometer forward until the measuring points come in contact with the ring gauge, the latter being held by an assistant. Clamp the brass clamp. Adjust the zero of the index ring to that of the scale, and set the locking ring up tight against the index ring. Unclamp the steel clamp. Test the adjustment of the index by turning the micrometer slightly to the left and then to the right, thus making contact with the ring gauge by means of the micrometer. If the adjustment be not perfect, repeat the operation. In measuring after each contact turn the micrometer to the left far enough to be able to move the gauge to its new position with ease.

The revolving head has not been fully described, as the design for it has never been before the board and no drawings are at hand. * * *

The board, as at present constituted, in view of experience had in the gun shop in the manufacture of service guns, with the instruments which have been described, submits the following remarks and recommendations in respect thereto:

Caliper arms.—The use of aluminium castings for caliper-arm frames is strongly recommended. Such arms can probably be used as hand calipers until the matter of size alone makes them too cumbersome for handling. Measurements with such arms can be made more accurately and expeditiously and with less fatigue. Wood lagging or some light wrapping may be necessary where the hand supports them in use. Such an arm, capacity 22 inches, has been made at this arsenal and used in the gunshop with especially satisfactory results.*

---

* The following relates to the aluminium caliper arm mentioned:

[2751B–'92.]

[Fifth indorsement.]

WATERVLIET ARSENAL, *August 31, 1892.*

* * * The aluminium caliper arm has been manufactured at this arsenal, the casting being procured from W. & L. E. Gurley. The caliper consists of an aluminium casting of the form shown in the drawing herewith, Pl. I_8. The two ends of this casting are slotted out, and there are inserted two steel micrometer sockets, also illustrated in the drawing. These latter are of a size to receive the steel micrometer points heretofore designed by the Board on Inspecting Instruments and described in their progress reports. The manner of use of the caliper arm differs in no respect from those heretofore described, except that larger sizes can be used without employing a supporting saddle. The caliper arm has been thoroughly tested in the shop and is found to be much preferable to those described * * * (steel, wood lagged) * * * on account of its lightness. It weighs but $2\frac{6}{16}$ pounds, whilst the steel arm of same size weighs $5\frac{13}{16}$ pounds. * * *

Measuring points for interior diameters: These are not considered entirely satisfactory. It is believed that it would be better to make and permanently attach lighter ferrule to each size of wooden holders above 10 inches, thus permitting the ferrule and holder to be made of a diameter properly proportionate to the length, with due regard to the stiffness of the holder. In the use of these points as micrometer points, frequent checking is necessary, owing to the changes in length due to handling.

* * *

In all places where milled-head clamp screws are used it is recommended that winged-head screws be substituted.

C. C. MORRISON,
Captain, Ordnance Department.
W. B. GORDON,
Captain, Ordnance Department.
F. E. HOBBS,
Captain, Ord. Dept., U. S. Army.

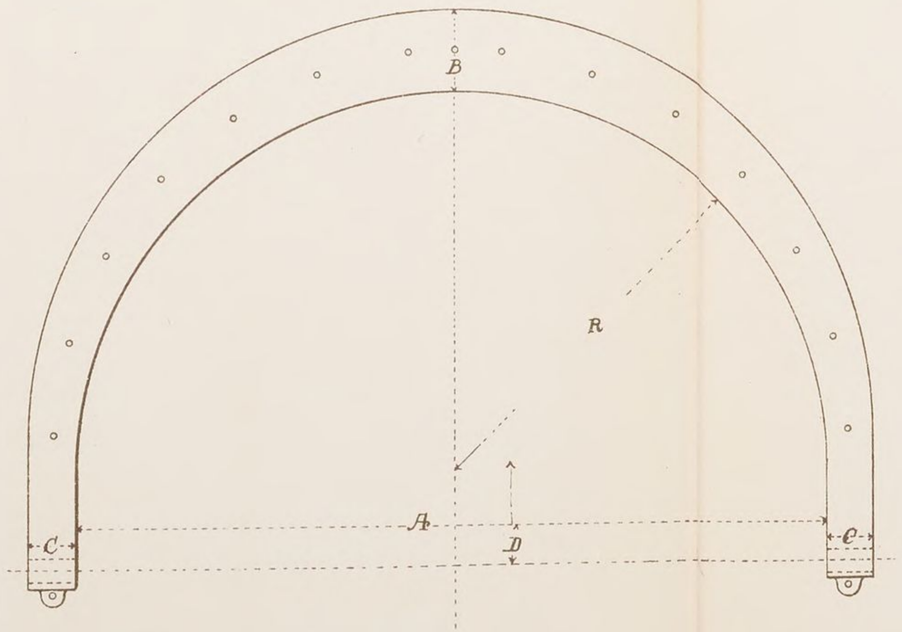
The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

(Through commanding officer Watervliet Arsenal.)

(4594 '92.)

CALIPER ARMS.

TABLE. OF DIMENSIONS.



CAPACITY OF FRAMES.	DIMENSIONS. A.	B.	C.	D.	R.
0 TO 5	6·1	1·	·75	·75	3·05
5 — 10	11·1	1·25	1·	1·	5·55
10 — 15	16·1	1·75	1·	2·	8·05
15 — 20	21·1	2·	1·	2·	10·55
20 — 25	26·1	2·	1·	2·	13·05
25 — 30	31·1	2·5	1·	2·	15·55
30 — 35	36·1	2·5	1·	2·	18·05
35 — 40	41·1	3·	1·	2·	20·55
40 — 45	46·1	3·	1·	2·	23·05
45 — 50	51·1	3·5	1·	2·	25·55
50 — 55	56·1	3·5	1·	2·	28·05
55 — 60	61·1	4·	1·	2	30·55
60 — 65	66·1	4·5	1·	2·	33·05
65 — 70	71·1	5·	1·	2·	35·55

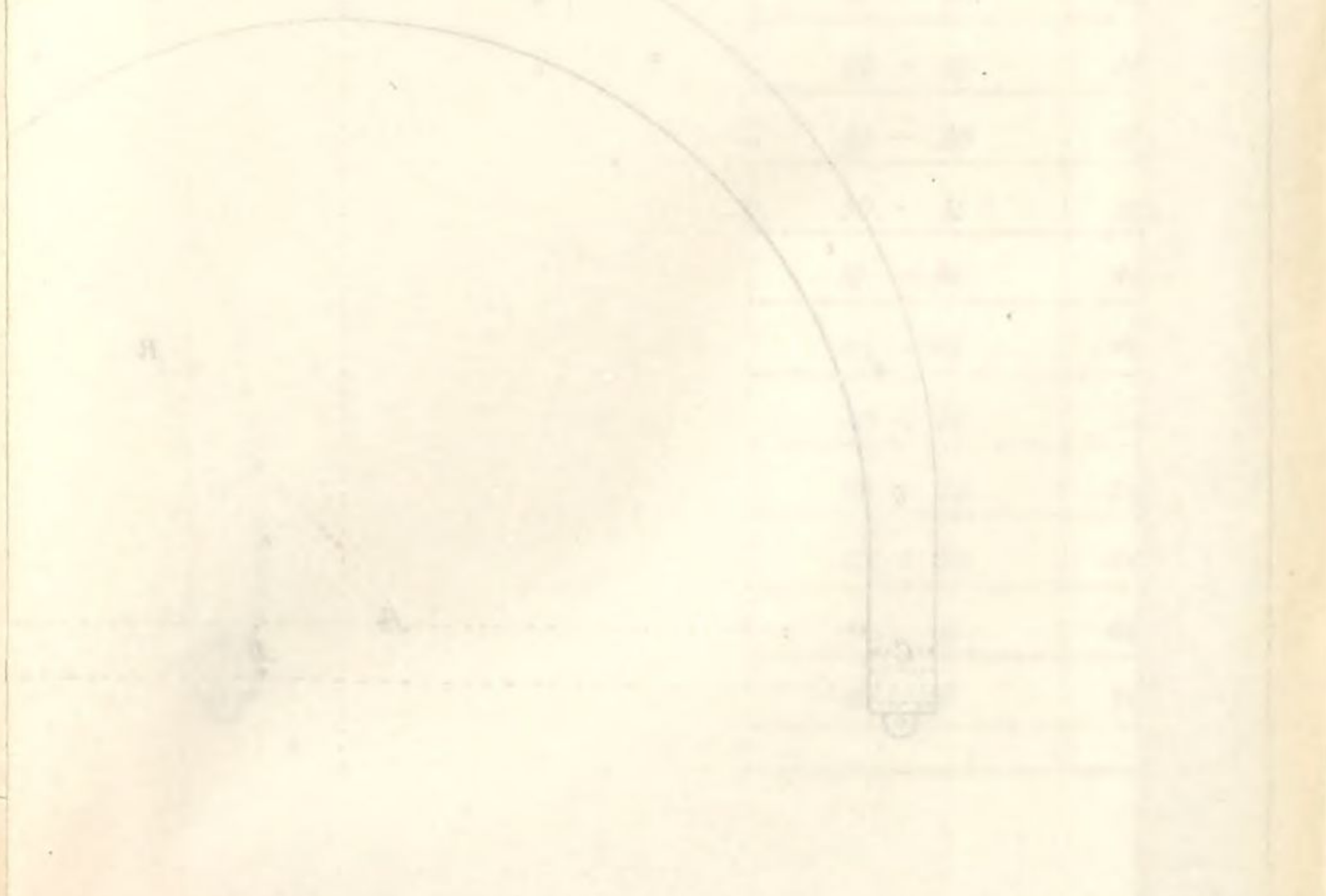
For the Board.

A. A. Noyes

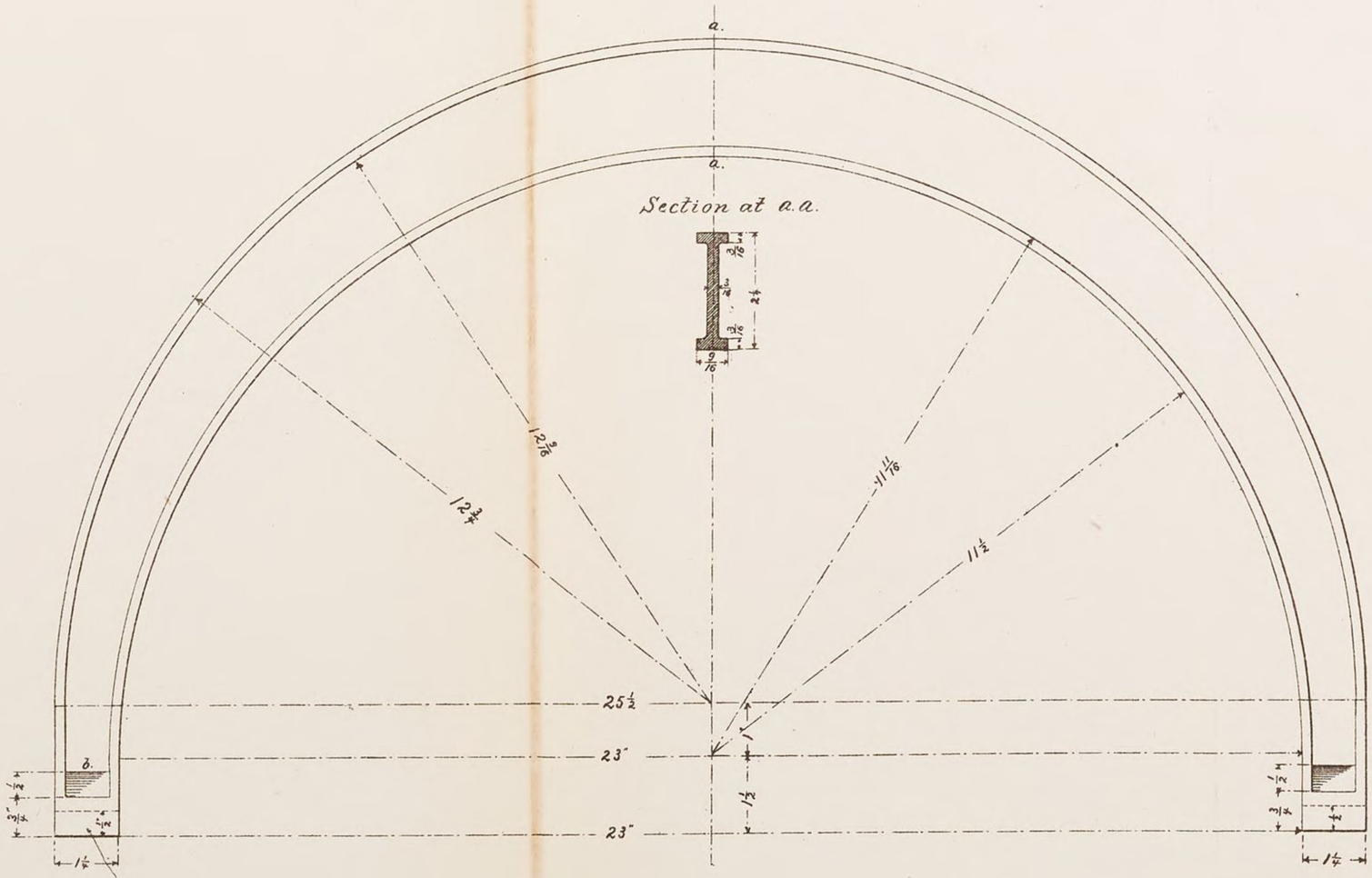
Captain Ordnance Dept. U.S.A

President.

Watervliet Arsenal. June. 24th 1892.

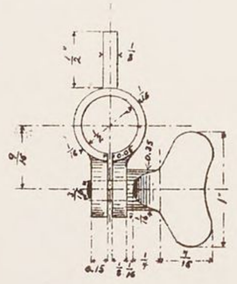


Aluminium Caliper Arm.
for Board on Inspecting Instruments

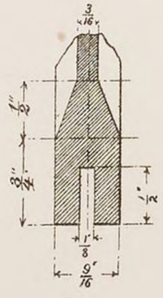


Section at a.a.

Steel micrometer-socket.
full size.

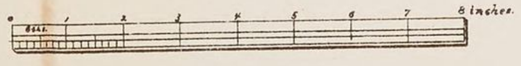


Section at b. full size.



Steel micrometer-sockets to be inserted and riveted to frame.

Scale.



For the Board:
C. C. Morrison
Captain Ordnance Dep't. U.S.A.
President.

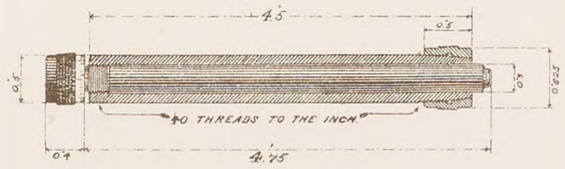
Appendix 50, 1892.

CALIPER ARM.

MEASURING AND FIXED POINTS.

Fig. 1.

Fig. 2.



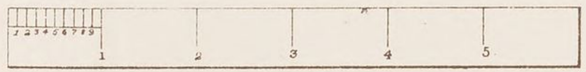


Fig. 4.

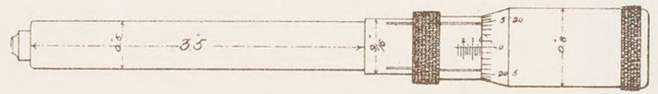
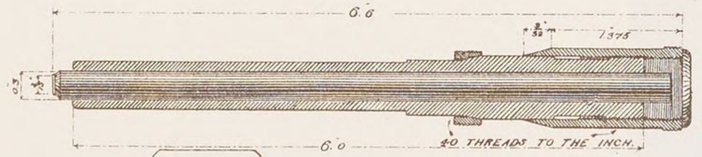
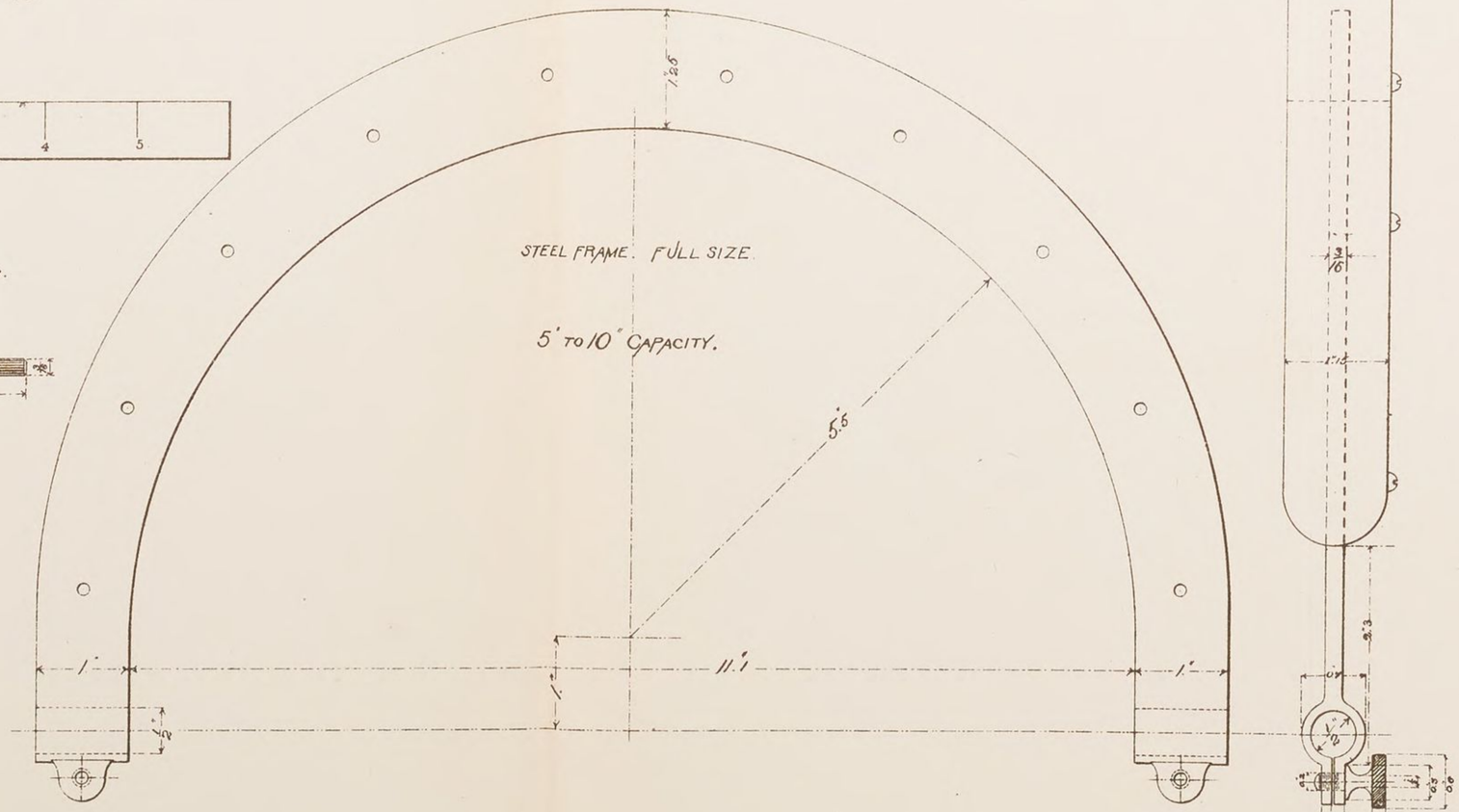


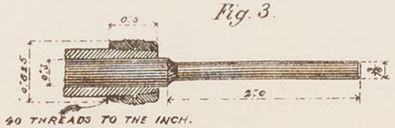
Fig. 5.



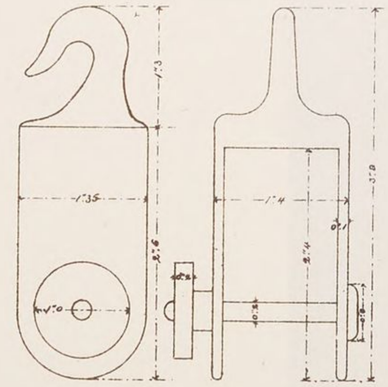


Fixed point for lips of hoops.

Fig. 3.



40 THREADS TO THE INCH.



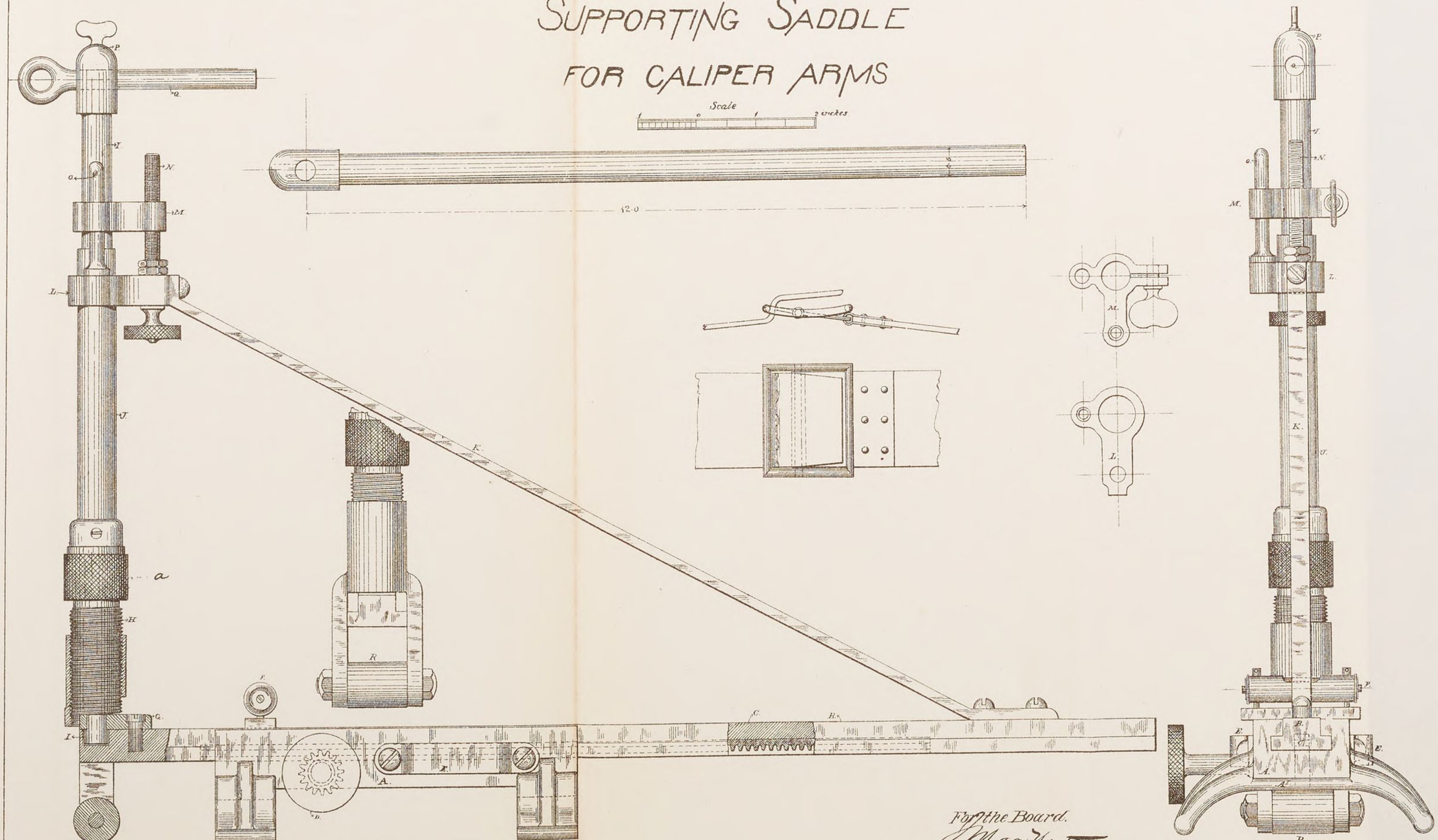
SIDE VIEW. BACK VIEW.

HOOK FOR CALIPER. FULL SIZE.

Watervliet Arsenal July 18th 1890.

For the Board.
Charles Shaler.
Captain Ordnance Dpt.
President.

SUPPORTING SADDLE FOR CALIPER ARMS



For the Board.
Mac Nutt
Captain Ordnance Dept. U.S.A.
President.

Appendix 50, 1892.

Fixed and measuring points for interior diameters. for diameters from 2 inches to 10 inches.

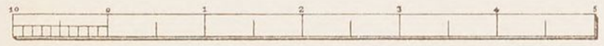


Fig. 2.

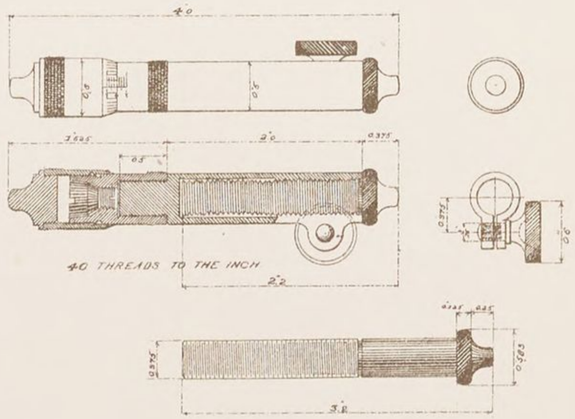


Fig. 3.

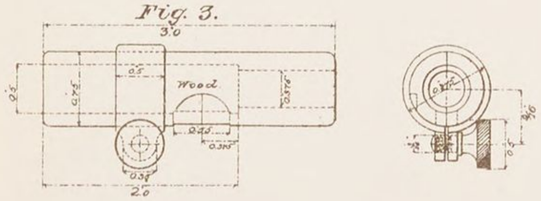


Fig. 4

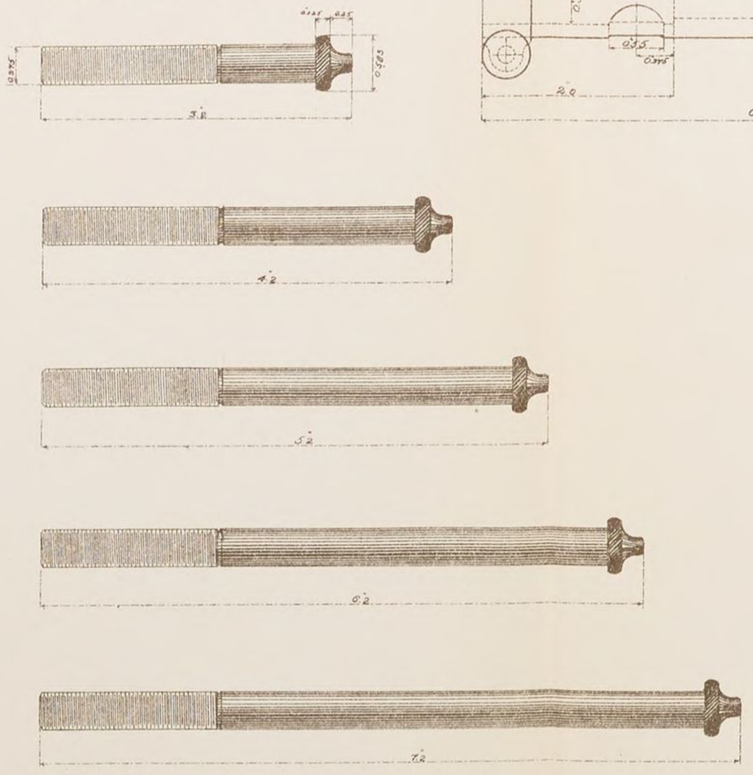
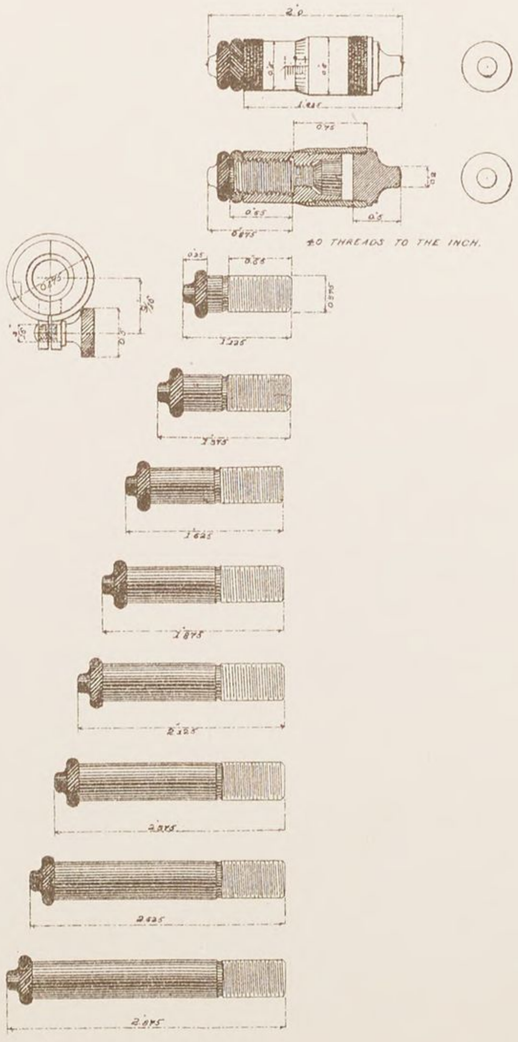


Fig. 1.



Watervliet Arsenal July 23rd 1890.

Appendix 50, 1892.

For the Board.
Charles Shaler,
Captain Ordnance Dpt.
President.

Fixed and measuring points for interior diameters.
for diameters above 10 inches.

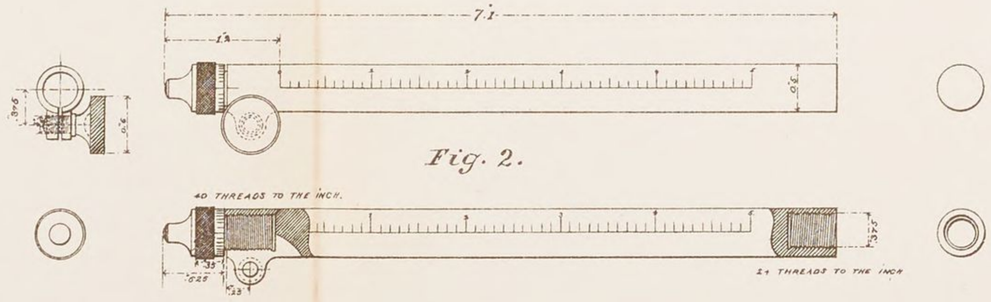


Fig. 2.

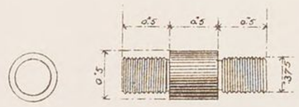


Fig. 4.

FIG. 4 & 5. 24 THREADS TO THE INCH.

Fig. 5.

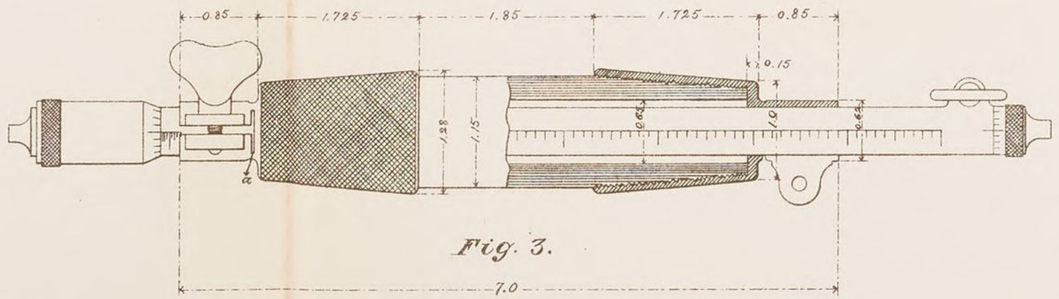


Fig. 3.

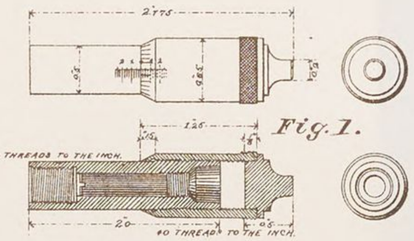
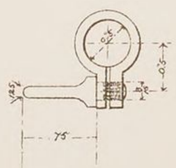
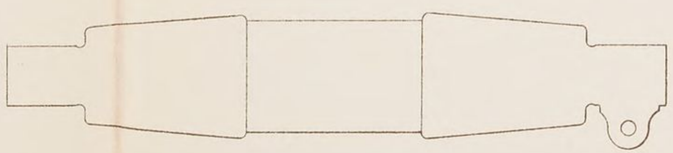
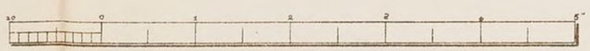


Fig. 1.







Watervliet Arsenal July 21st 1892.

Appendix 50, 1892.

For the Board.
O. D. Morrison
Captain Ordnance Dpt.
President.

Micrometer for Surface Lengths

Scale.

Fig 1. [Assembled]

Fig 5.

Fig 2

Fig 4.

Guide Block

Fig 3.

Fig 1
End Elevation

Fig 6.

Fig 7.

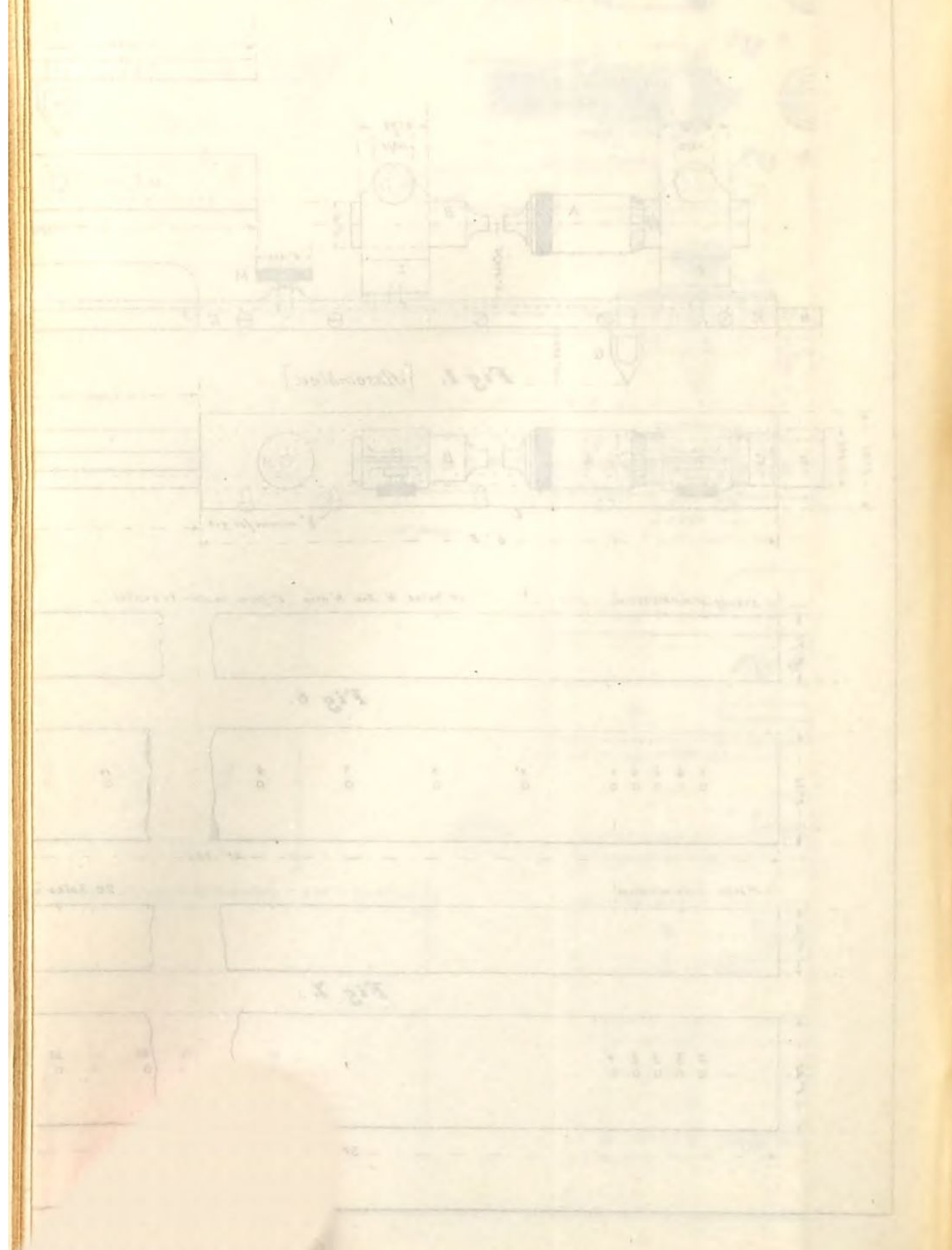
Fig 8.

Fig 9.

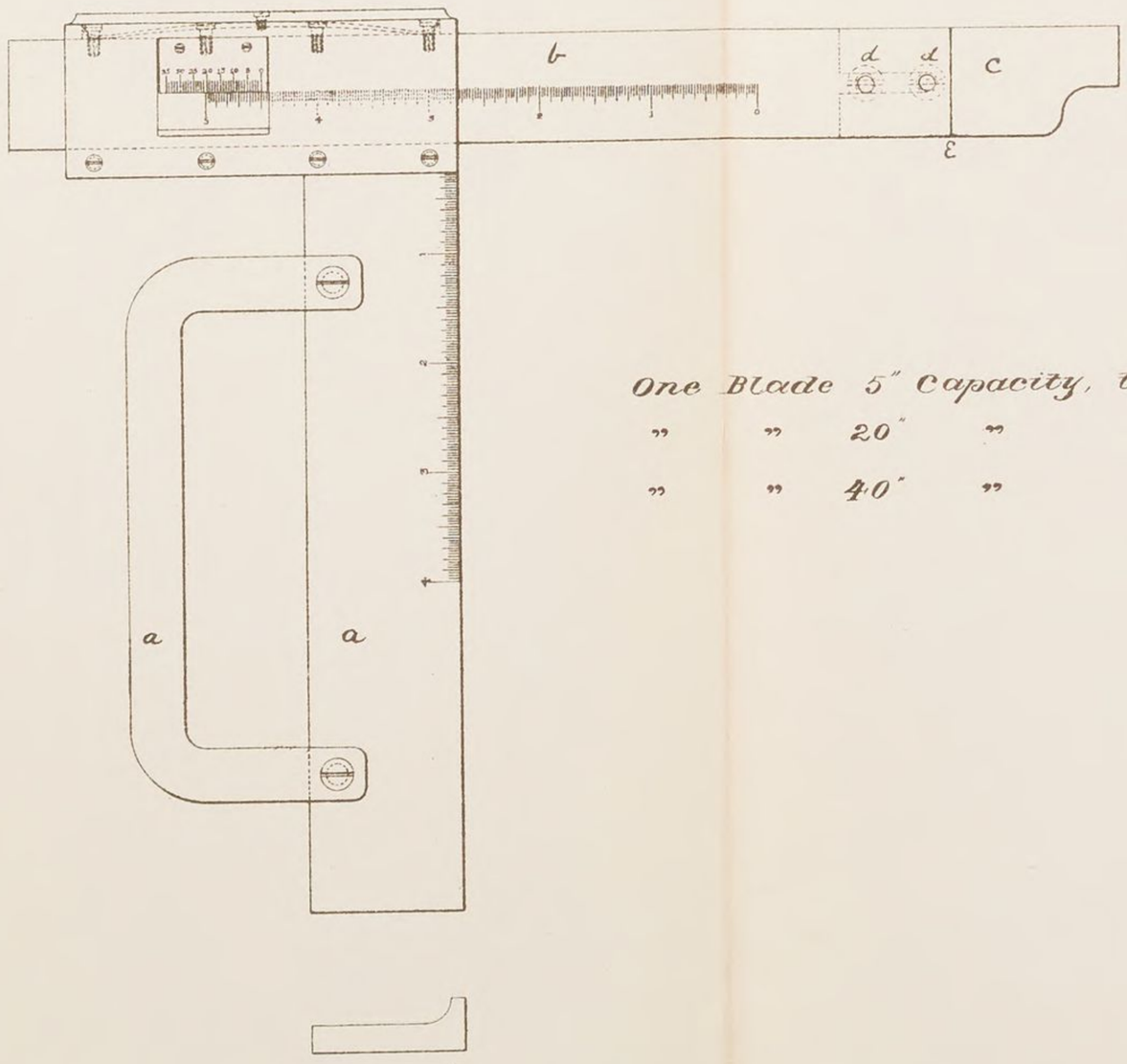
Fig 10

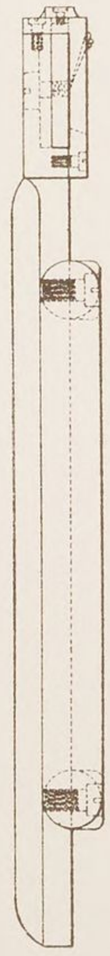
Appendix 50, 1892.

For the Board
O. D. Morgan
Captain Ordnance Dep't.
President



Step Gauge.



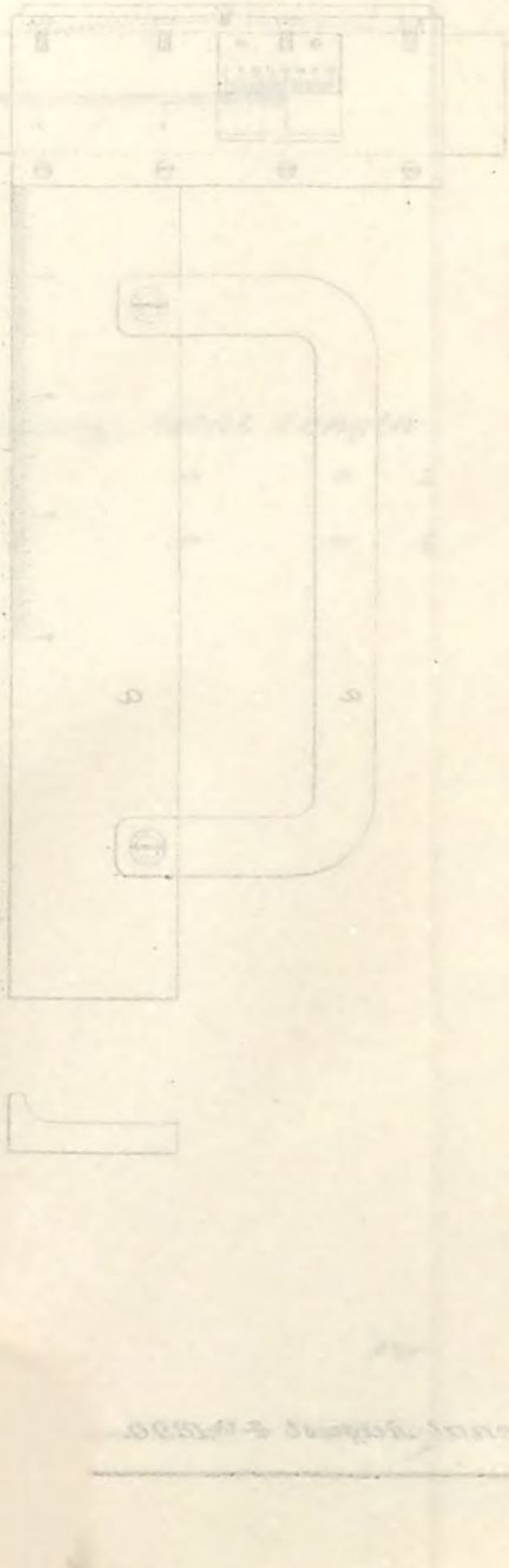


One Blade 5" Capacity, total length 8.5
" " 20" " " " 23.5
" " 40" " " " 43.5

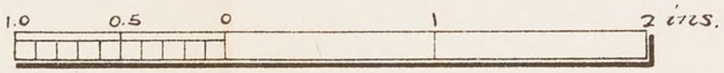
Waterrtiet Arsenal August 4th 1890.

For the Board.

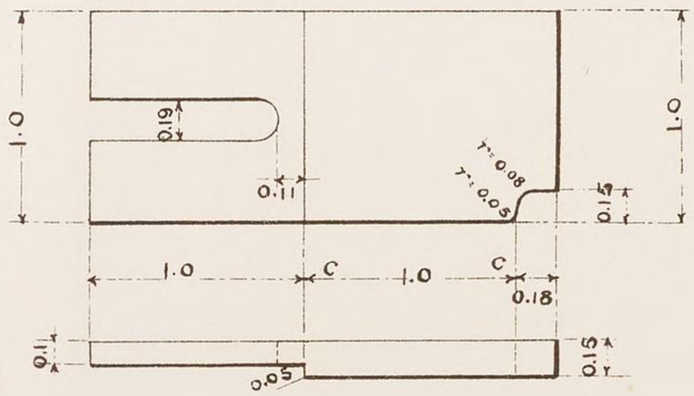
Appendix 50, 1892. Captain Ordnance Dpt.
President.

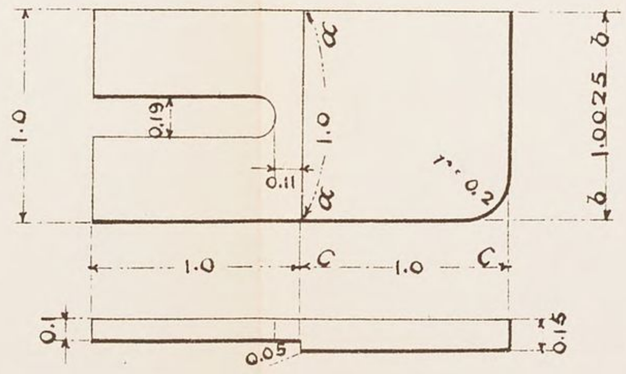


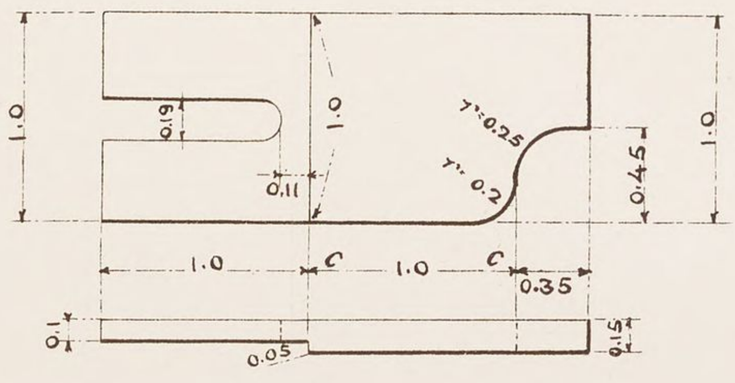
Templets for Step Gauge — 8 inch B.L Rifle.



$bb - aa = 0.0025$







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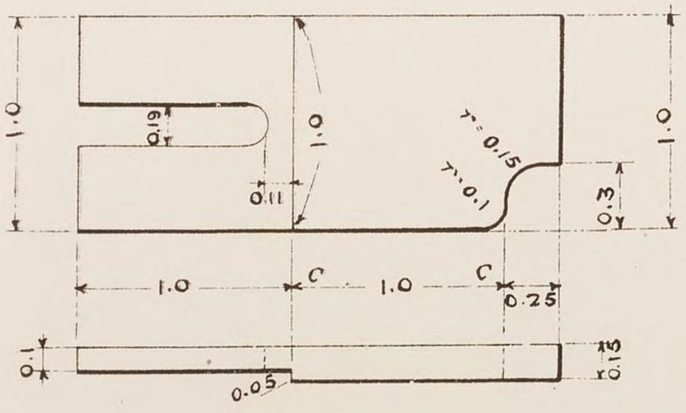
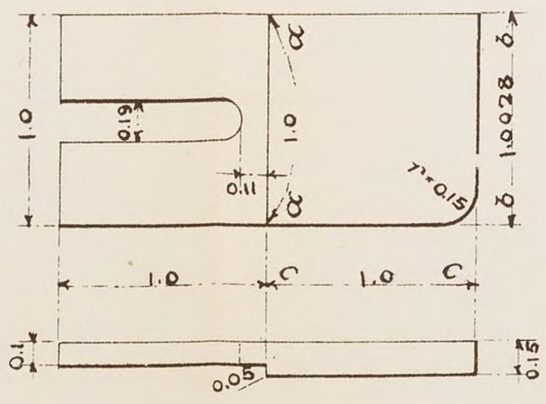
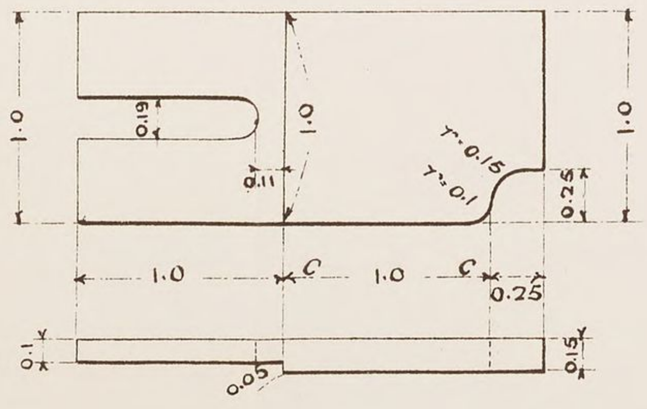
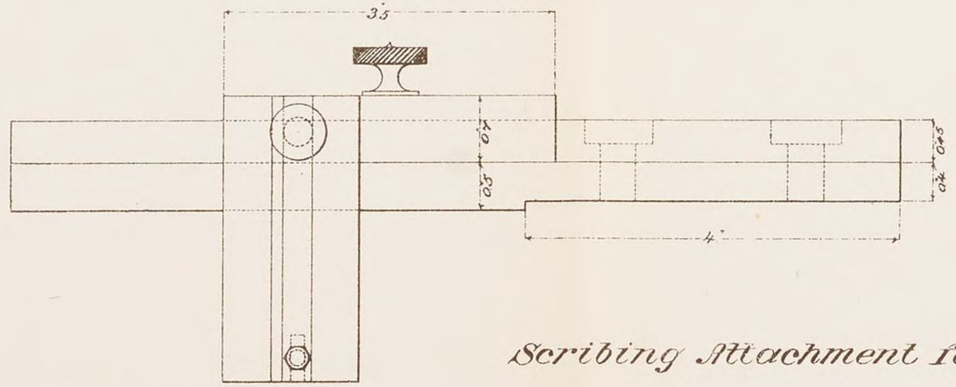


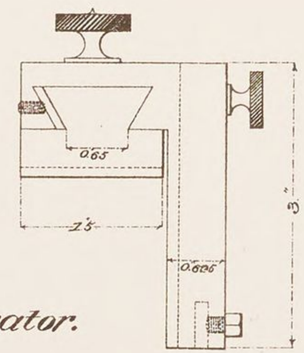




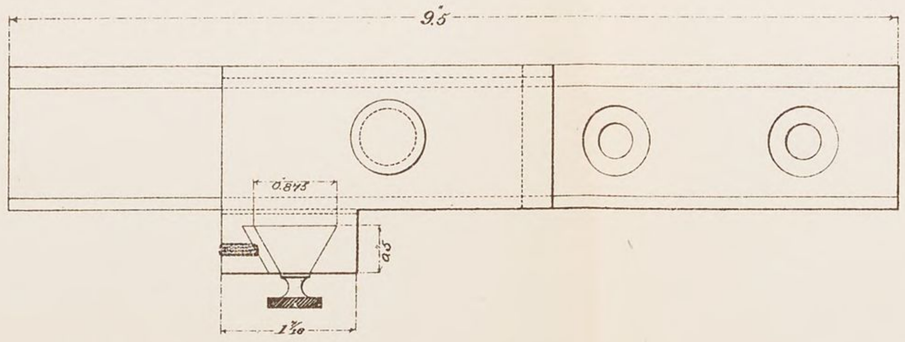
Exact length CC to be marked on each templet

Appendix 50, 1892.

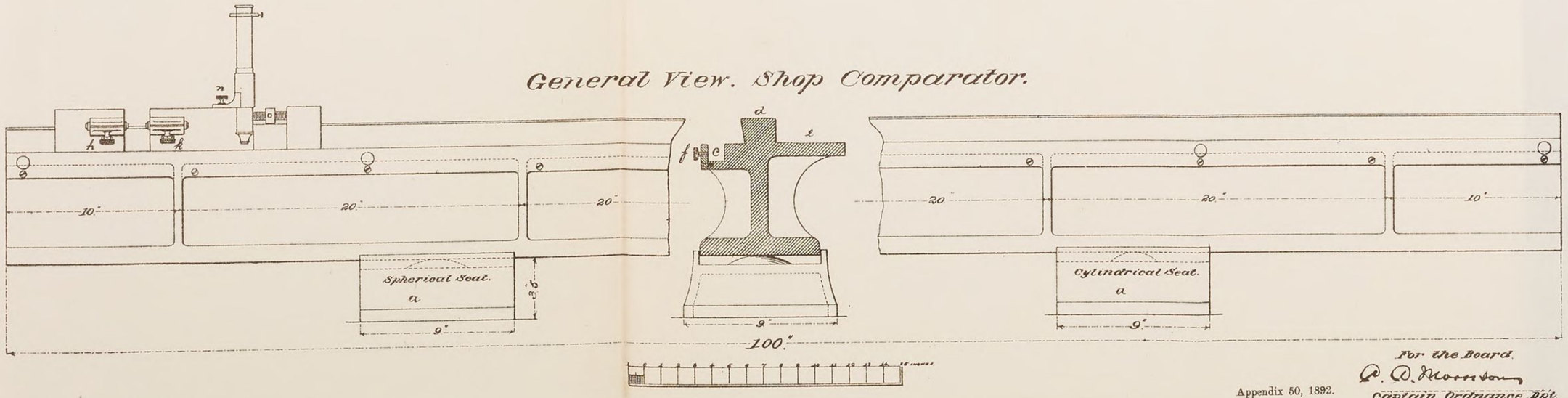




Scribing Attachment for Comparator.



General View. Shop Comparator.



Watervliet Arsenal August 26th 1890.

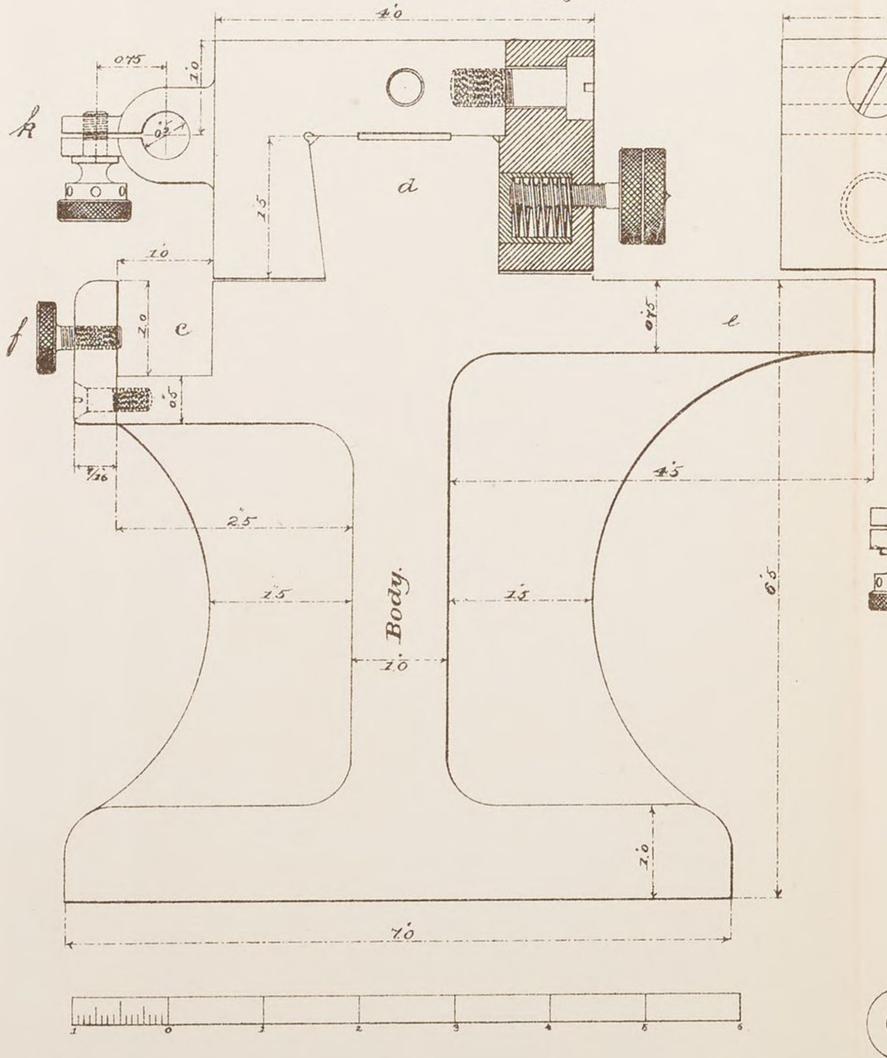
Appendix 50, 1892.

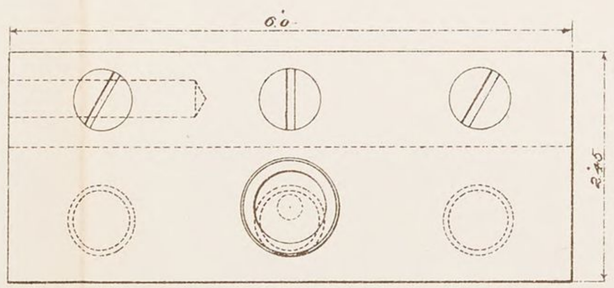
For the Board.
P. D. Moorsom
Captain Ordnance Dpt.
President.

Ord 52 2

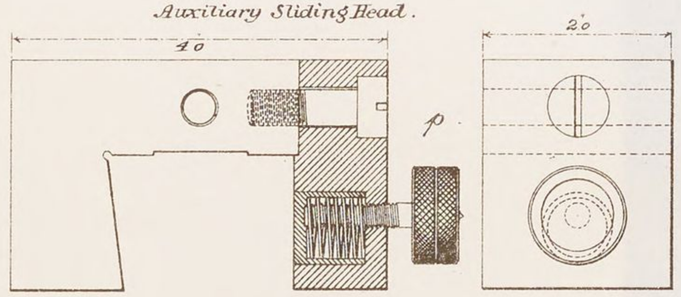
Shop Comparator.

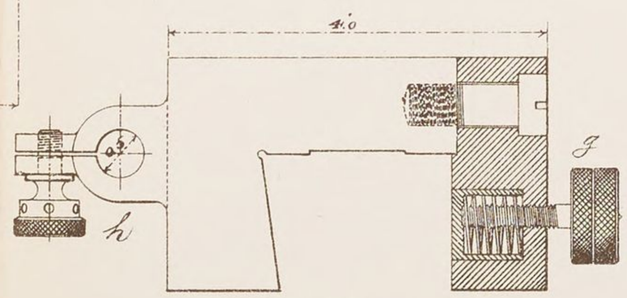
Sliding Head.





Auxiliary Sliding Head.





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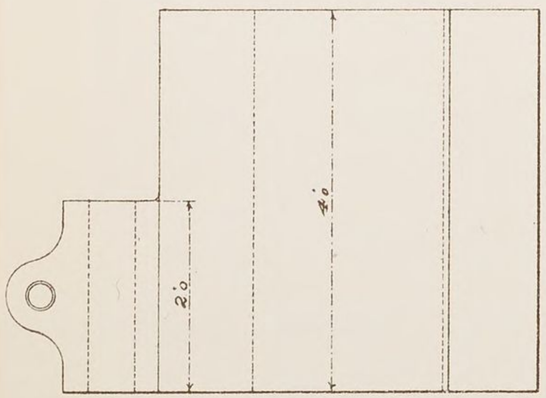
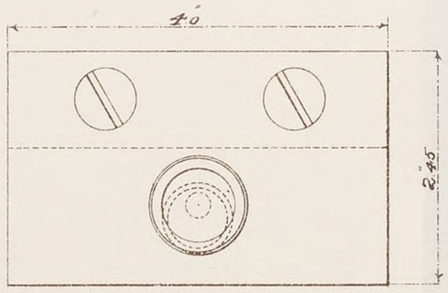
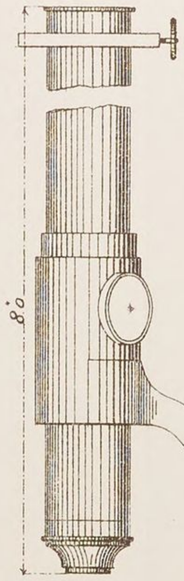
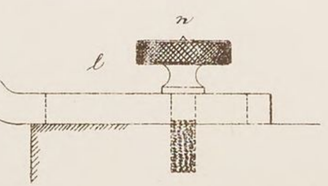






Microscope Mounting.



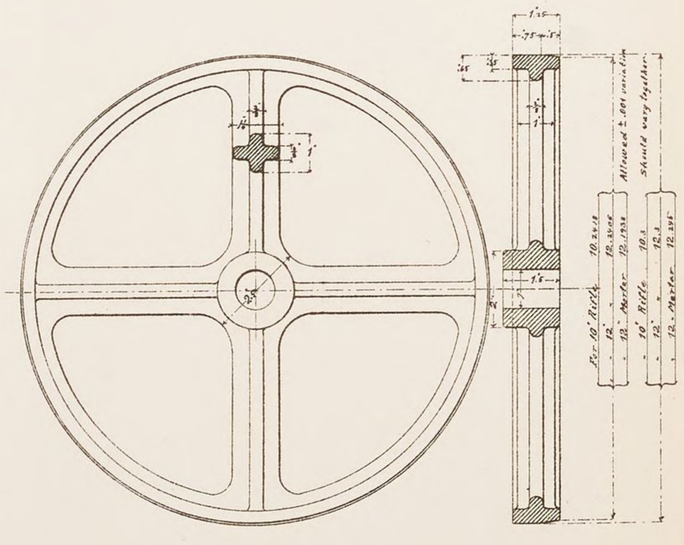
Watervliet Arsenal June 27th 90

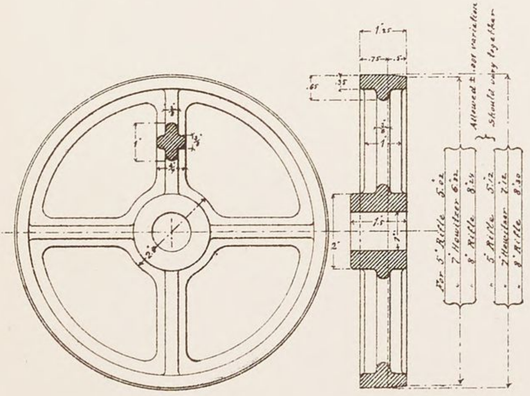
Appendix 50, 1892

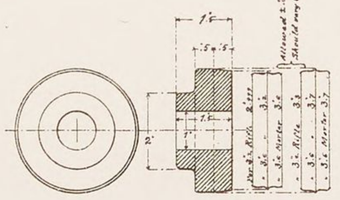
For the Board
C. Q. Rucker
Captain Ordnance Dept
President.

Chamber length Gauge.

Scale.







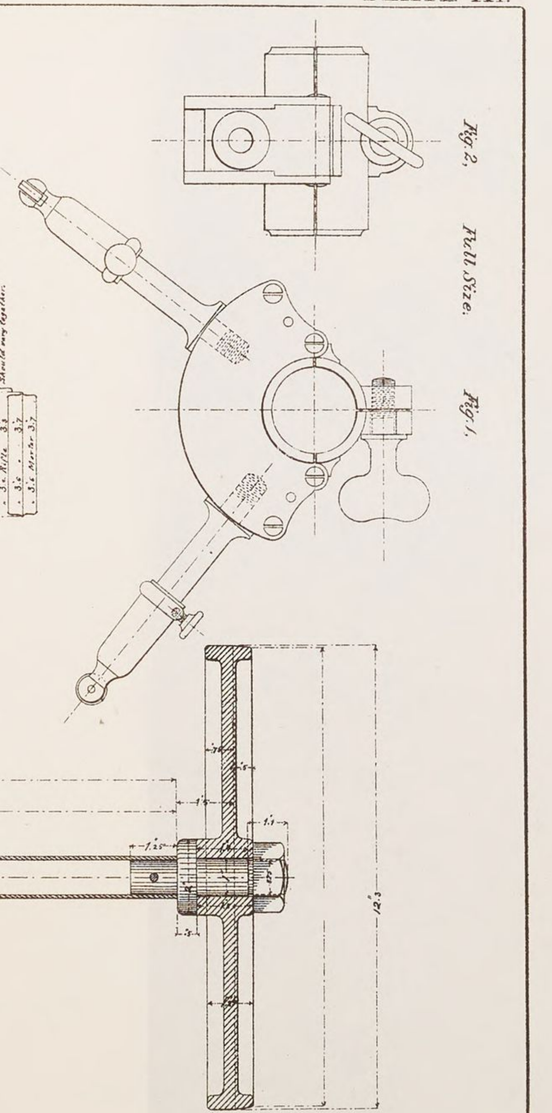
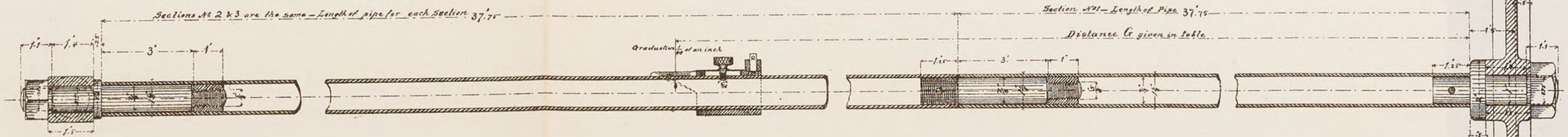
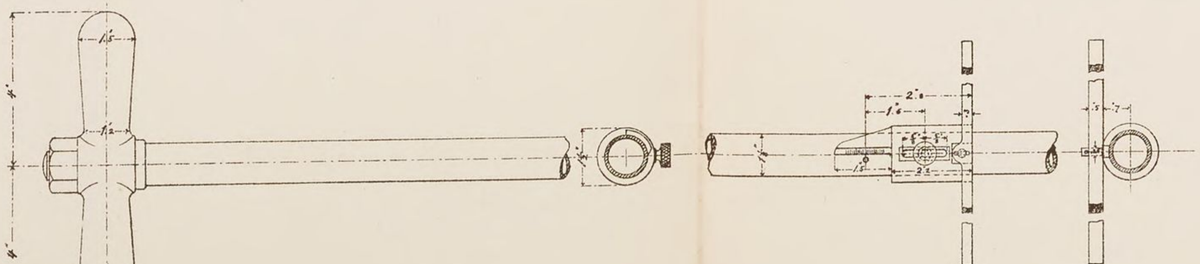


Fig. 2. Full Size. Fig. 1.



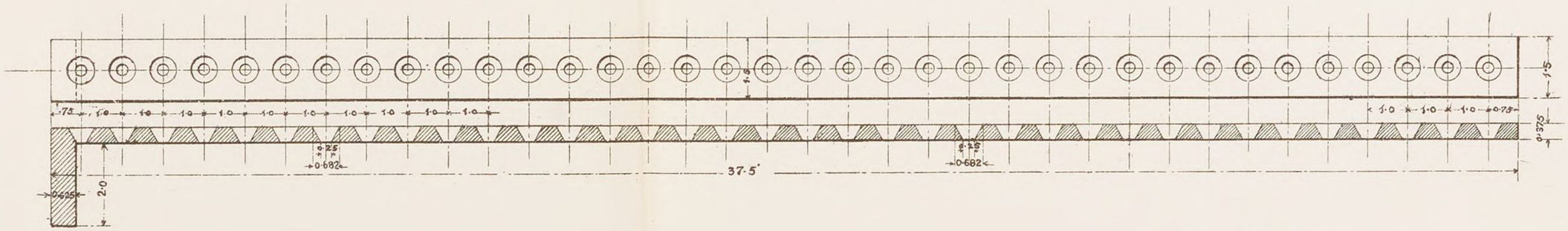


Denomination of Guns	Distance G on Staff	Length of Straight edge F.
3.2 in Rifle	18.784	6.0
3.6 " "	22.25	6.0
3.6 " Mortar	10.45	6.0
5.0 " Rifle	21.57	6.0
7.0 " Howitzer	14.39	8.1
8.0 " Rifle	59.30	10.4
10.0 " "	74.99	13.4
12.0 " "	88.58	15.8
12.0 " Mortar	30.116	13.4

For the Board.
P. D. Harrison
Captain Ordnance Dept.
President.

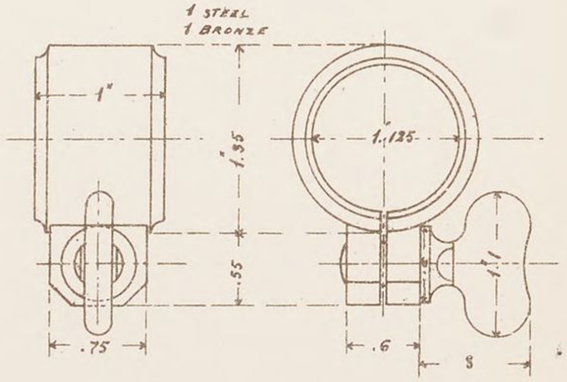
Appendix 50, 1892.

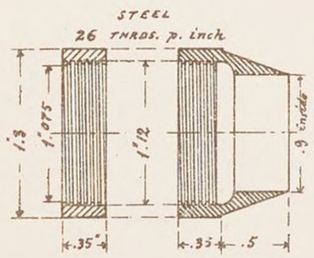
Interior length Gauge.

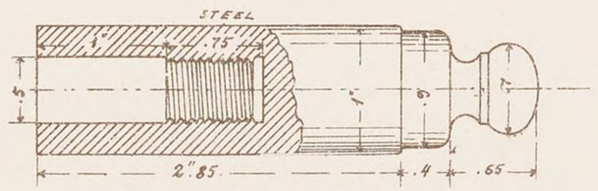

1·5
1·5
·75
1·0 1·0 1·0

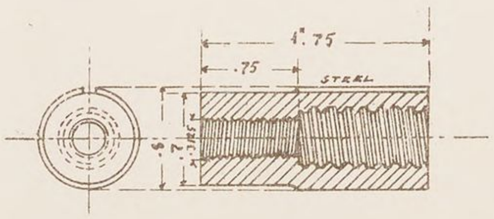
Details of Micrometer Handle & Cone for Star Gauge

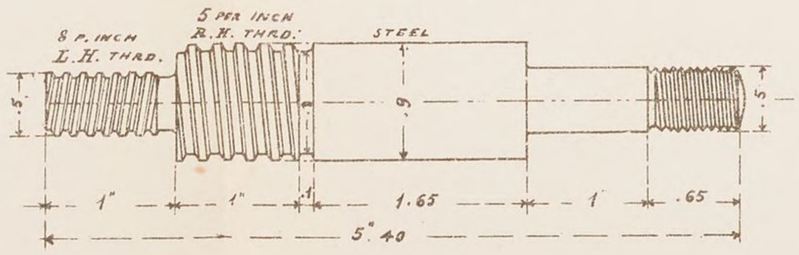
SCALE : FULL SIZE





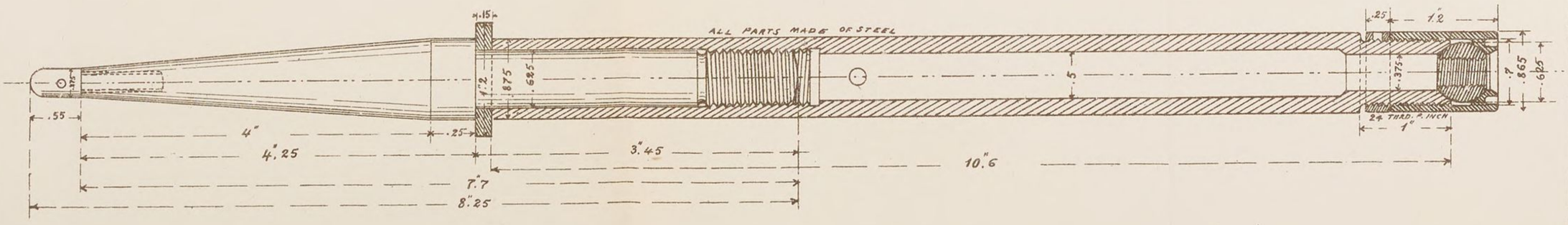






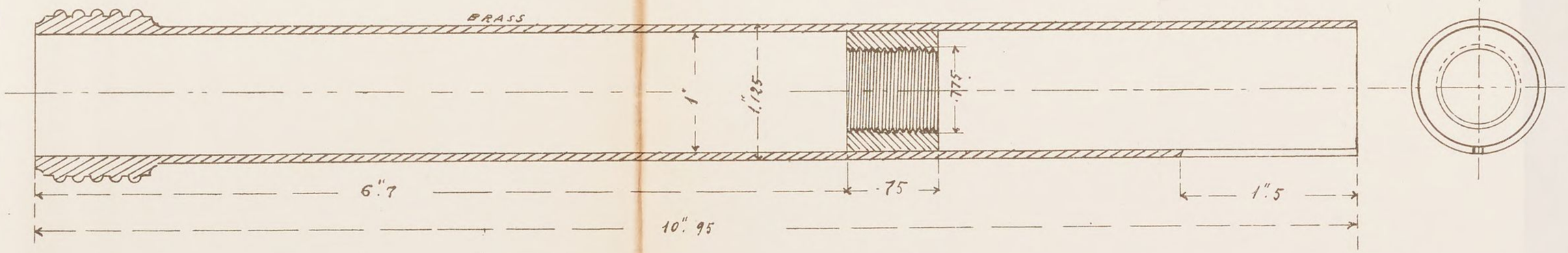
Frankford Arsenal
May 1892

H. C. Gardy
LIEUT. COLONEL OF ORDNANCE
COMMANDING

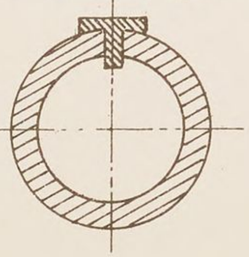


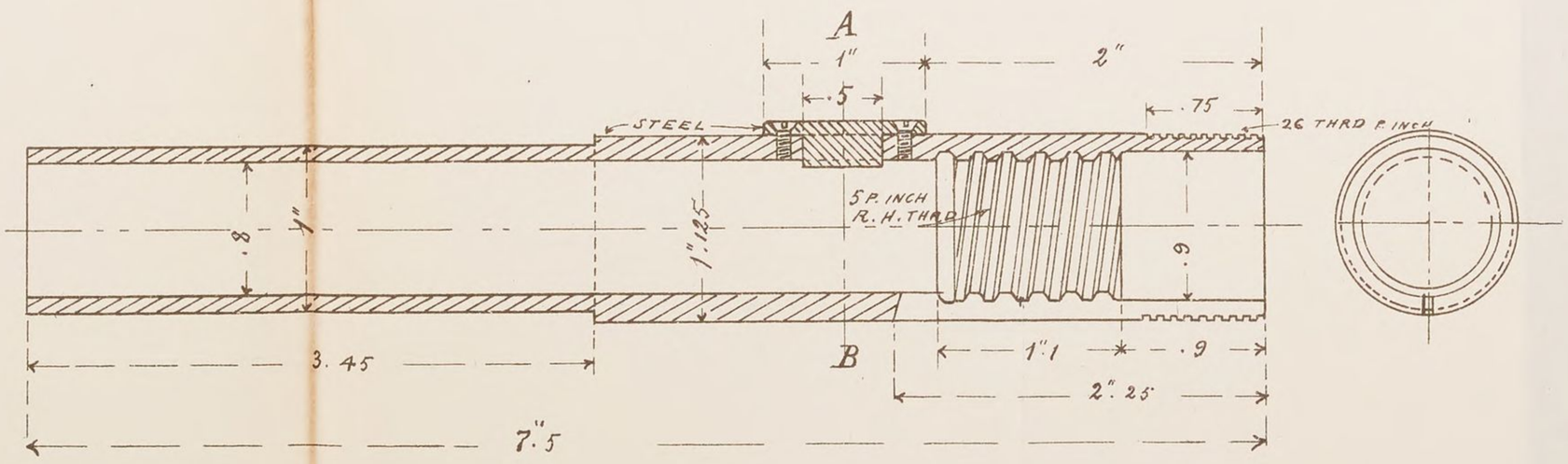
Appendix 50, 1892.

Details of Micrometer Handle for Star Gauge — SCALE : FULL SIZE



Section on A, B



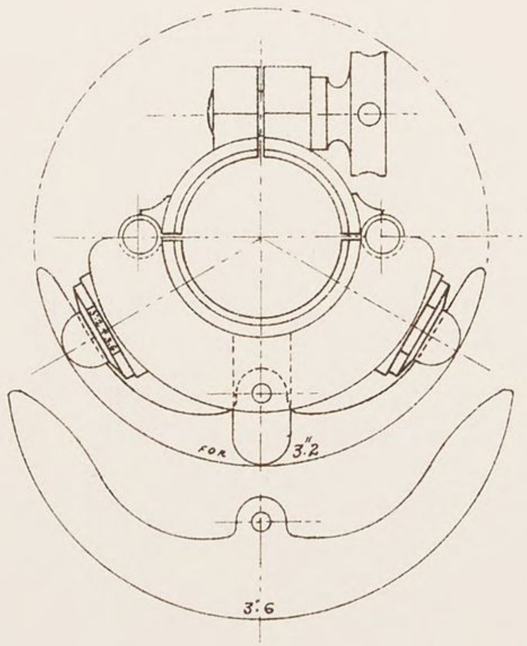


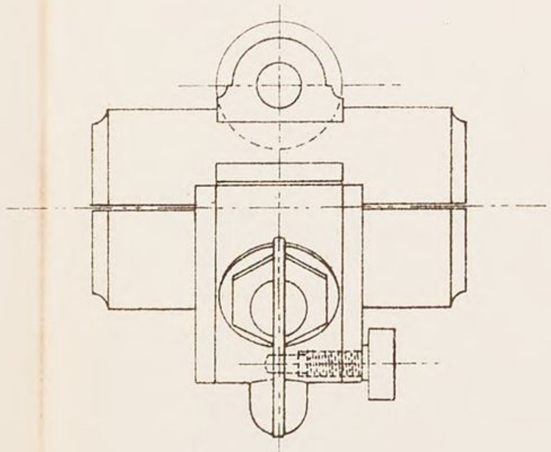
Frankford Arsenal
May 1892

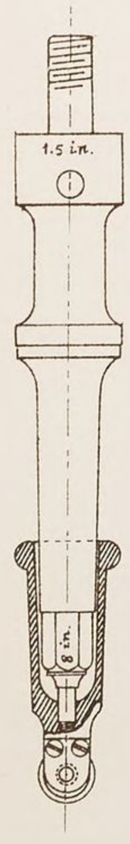
LIEUT. COL. OF ORDNANCE
COMMANDING

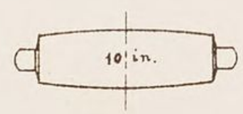
Interior Rest for Star Gauge — H. WERNLE DES. Scale: Full size

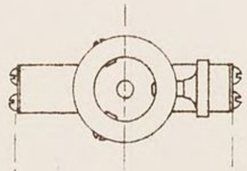
Frankford Arsenal
March 1892
J. Putnam
CAPTAIN OF ORDNANCE
COMMANDING

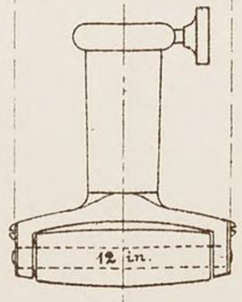


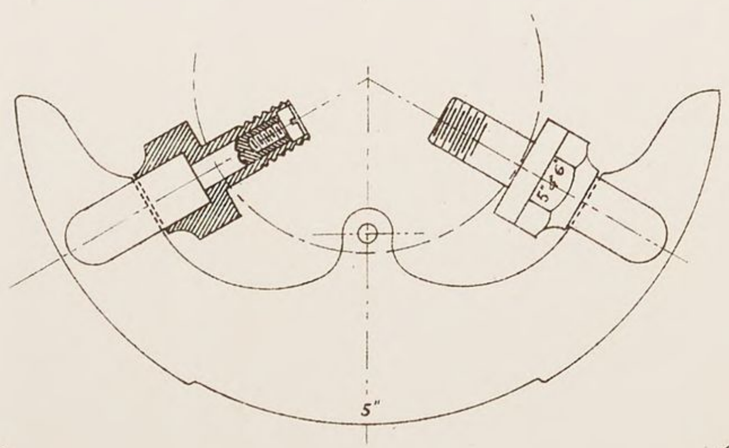


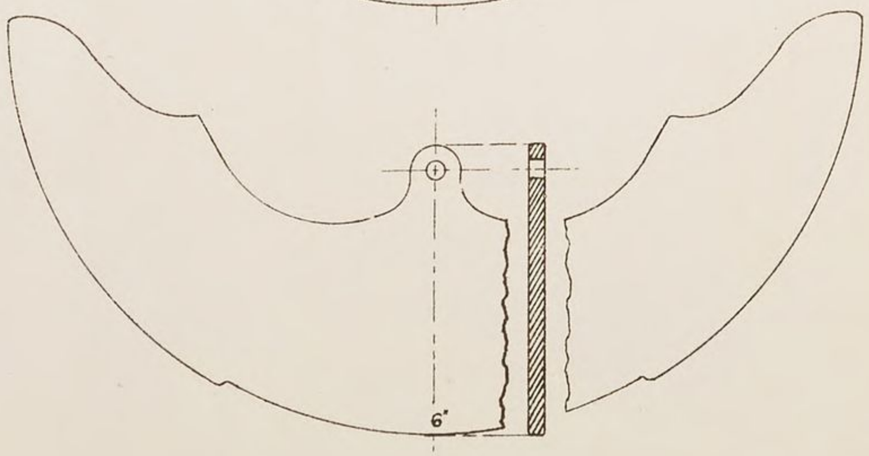












Exterior Rest for Star Gauge Staff.

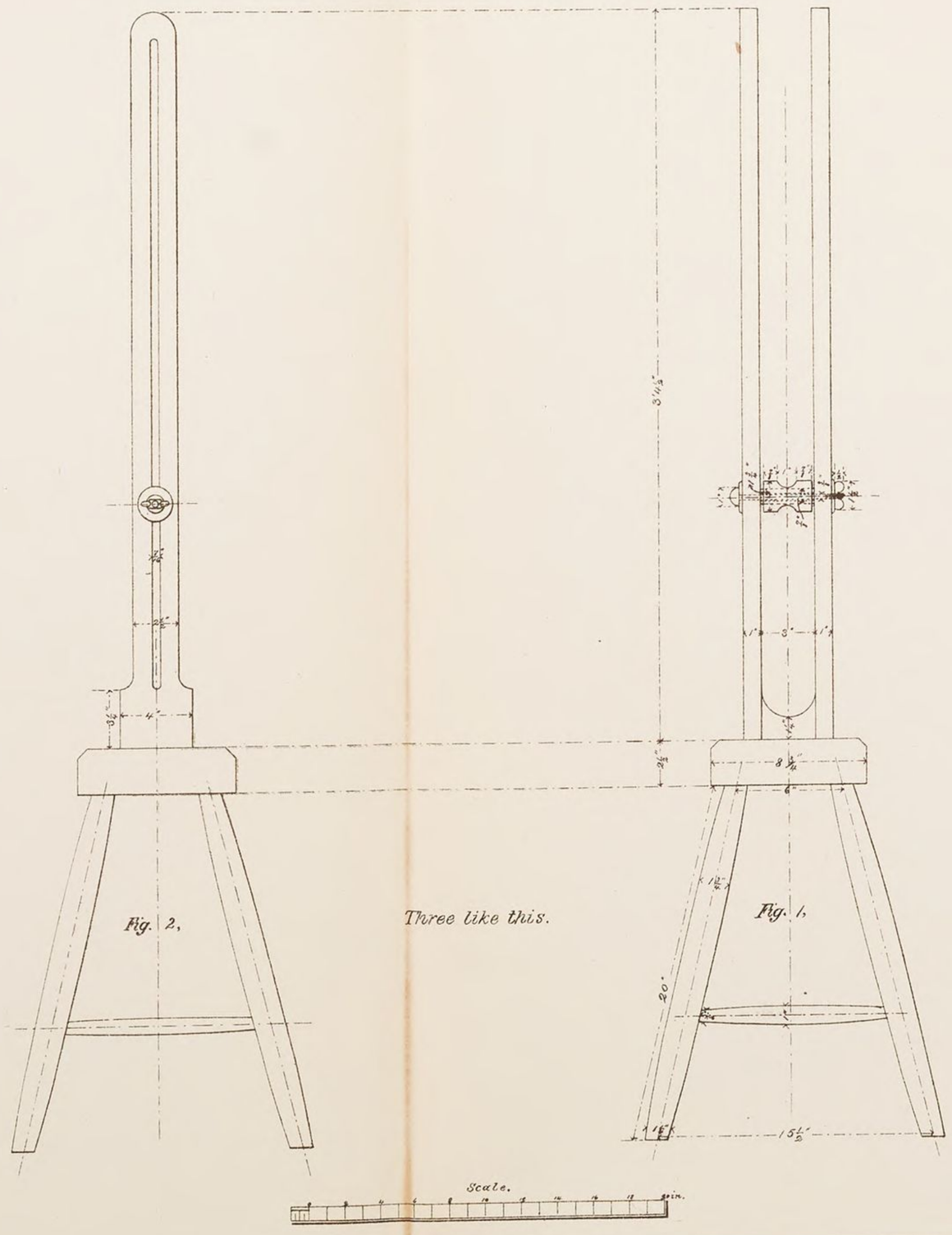


Fig. 2.

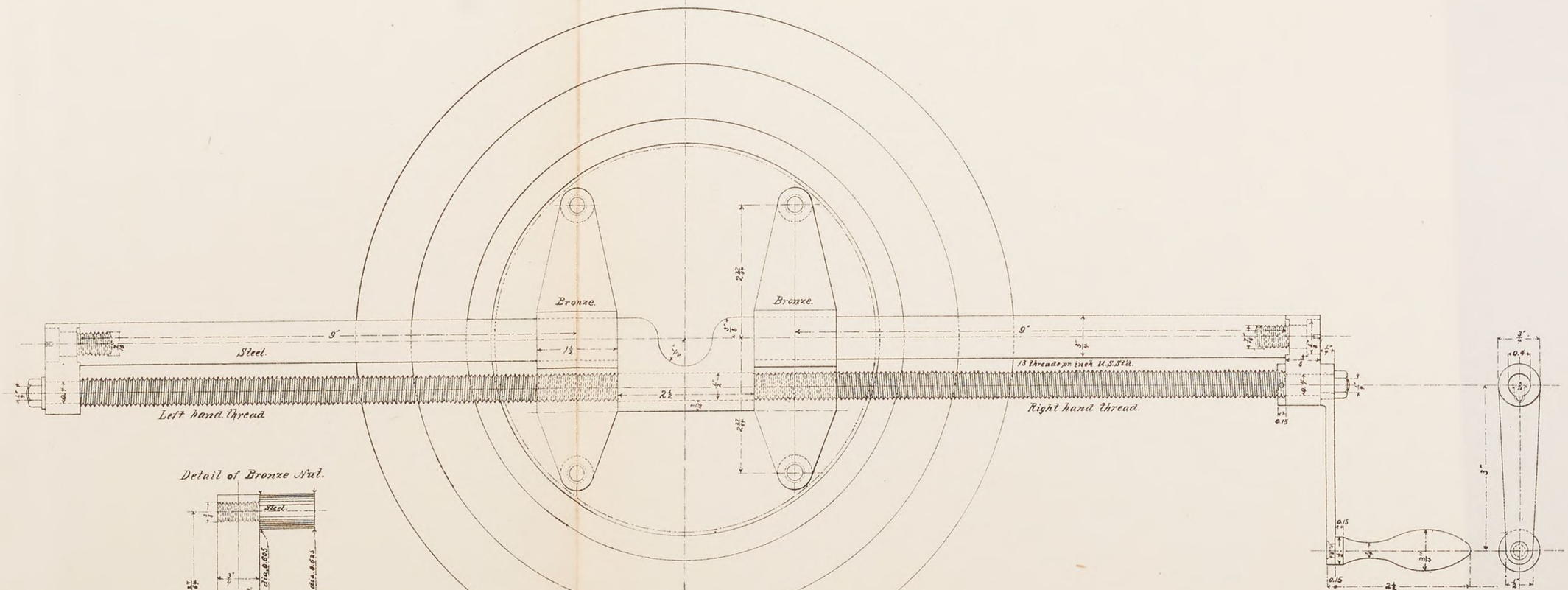
Three like this.

Fig. 1.

Scale.

By the Board.
D. D. Morrison
Captain Ordnance Dept.
President.

Muzzle Rest for Star Gauge.
for Board on Inspecting Instruments.



For the Board.

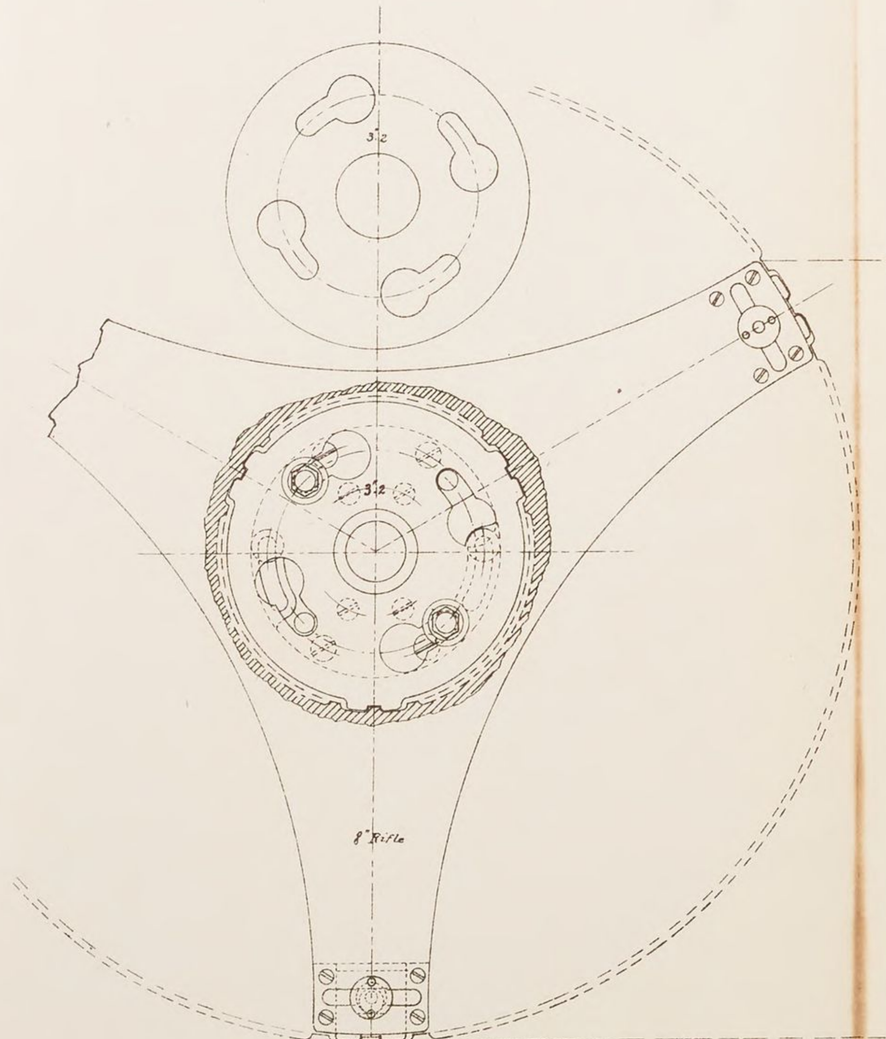
D. D. Harrison
Captain Ordnance Dept
President.

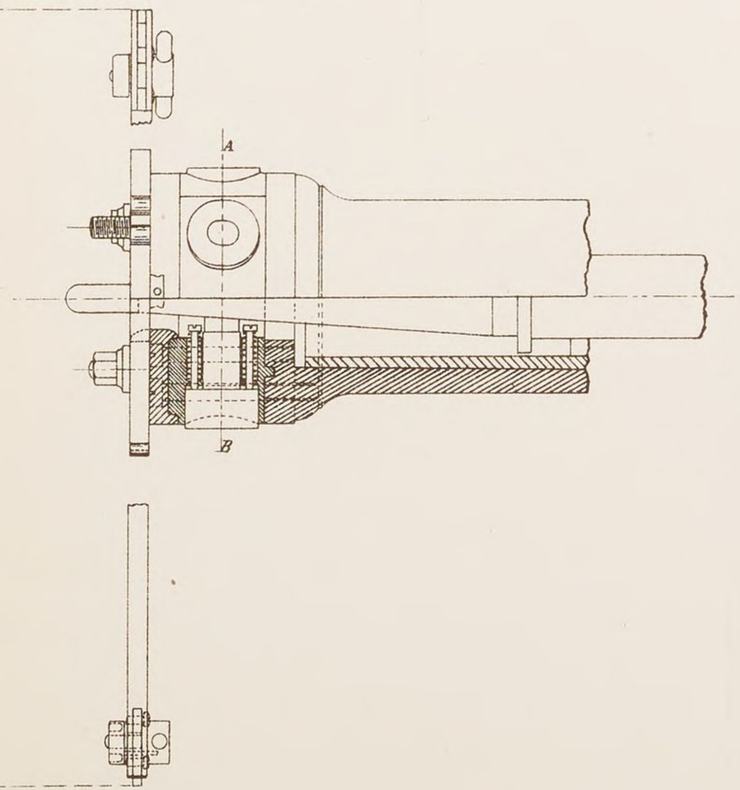
Appendix 50, 1892.

Rifle Guide & Head Supports for Star Gauge with revolving head – H. WERNLE DES.

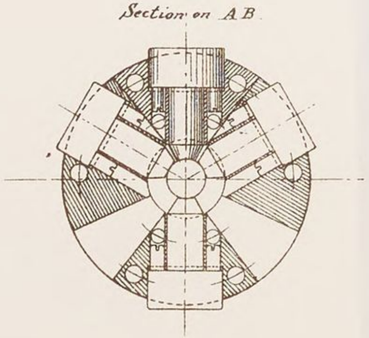
Scale : Full size

Frankford Arsenal
March 1892
J. Ritman
CAPTAIN OF ORDNANCE
COMMANDING





Section on A B



APPENDIX 51.

REPORT ON SMALL-ARM TARGETS, BY LIEUT. COL. D. W. FLAGLER, ORDNANCE DEPARTMENT.

ROCK ISLAND ARSENAL, ILL., *May 11, 1886.*

SIR: I have the honor to submit the following report, giving lists of targets and of the spare parts which may be required for issue to the Army for the three systems of targets now in use, and such other information as may be required by officers in making requisitions for these targets and parts for the same, with the view, should you deem it wise to do so, that a general order or a pamphlet be published giving this information to the Army.

(This report does not include steel skirmish targets.) There are three systems of targets now in use in the Army (including the steel skirmish targets), viz: The revolving targets (Laidley), four sizes and patterns; the sliding target, two sizes; the rolling target, one size.

(Since this report was made the revolving target (Texas) has been added to the list.)

Confusion has arisen in the nomenclature of targets. To avoid this confusion the following nomenclature should be followed in making requisitions:

TARGETS.

A target complete is the whole apparatus of wood, iron, etc., on which the paper target is to be exposed, and includes the necessary target frames. The targets are designated by the name of the system and size, *e. g.*, revolving target (Laidley), 6 by 6 feet, vertical axis; sliding target, 6 by 12 feet, etc.

Target frames.

A target frame is the light detachable wooden frame on which is stretched the cotton cloth for mounting the paper target. Six target frames are now issued with each target complete. Only two of these frames are used at one time on the revolving (Laidley) target and on the sliding target, and one or two on the rolling target. The others are extra target frames, to be substituted as the frames are destroyed by firing. The target frames are the only parts of the targets exposed to hits or injury, and are, therefore, the only parts that should often require renewal. A soldier can readily detach a target frame from the target and put in a new one. Extra target frames are, therefore, furnished to the Army as required. They are packed in lots of six, and are issued in lots of six, or multiples of the same. Six target frames is the unit of issue. Also, the parts of target frames are detachable and interchangeable, and a soldier can readily take out a broken part and put in a new one. Parts of target frames for renewing broken pieces are packed and issued to the Army in quantities as required.

Cotton cloth.

Cotton cloth for mounting on the target frames is issued by the yard. Two yards are required for a 6 by 6 foot target frame, and four yards for a 6 by 12 foot target frame.

Paper targets.

Paper targets are designated.	Unit of issue.	Paper target centers are designated.	Unit of issue.
Paper targets A	50	Paper target centers A	50
Paper targets B	50	Paper target centers B	50
Paper targets C	25	Paper target centers C	50

Paper targets and paper target centers are carefully packed for transportation in bundles containing the above units of issue, and can not be issued in quantities other than these units or multiples of the same without considerable trouble and expense. Requisitions should conform to these units. Paper targets C can be used on 6 by 12 feet target frames only—for all three kinds of targets. For the rolling target, paper targets A and B are also used on the 6 by 12 feet target frames. For the other two patterns of targets, paper targets A and B are used on the 6 by 6 feet target frames, but can be mounted on 6 by 12 feet frames.

Nomenclature of parts.

The following lists of targets and parts of targets give the nomenclature to be used in making requisitions for targets and for parts of targets for making repairs. Supply tables fix a permanent allowance of targets for posts and firing grounds. When a post or firing ground is once supplied with its outfit of targets, new targets should not be supplied until the old targets have been condemned by an inspector, but spare parts for repairing old targets are furnished as required. When a target is condemned it should be broken up and the good parts retained at the post, or be turned in for the repairs of other targets. Target frames are perishable; that is, they are destroyed by the firing, and supply tables fix an annual supply of extra target frames for each target allowed to a post or firing ground, and extra parts of target frame are supplied for replacing broken parts. Target frames should not be dropped from returns, except through the action of an inspector, and they should then be "broken up," and the good parts retained for use at the post in repairing other target frames. Supply tables fix an annual allowance of cotton cloth and paper targets. These are perishable and are expended and dropped.

In the following lists of parts of targets the parts of the target frames are not given. The lists of parts of target frames are given on pages 986 and 987, under the head of "Parts of target frames," because separate requisitions will be made for extra target frames and parts of the same, and some parts of frames are interchangeable with others of different patterns and sizes. A knowledge of this will enable officers to economize and utilize parts which would otherwise be thrown away.

REVOLVING TARGETS (LAIDLEY).

Four patterns and sizes, viz:

6 by 6 feet vertical axis.
6 by 12 feet vertical axis.
6 by 6 feet horizontal axis.
6 by 12 feet horizontal axis.

A vertical axis target complete consists of the following parts. These parts are the same for both sizes of targets, except that some of their dimensions differ, and requisitions should state for which size they are required:

Parts of a vertical axis target.

1 axis.
2 levers.
2 nave boxes.
1 center or lever block.
4 large wedges.
2 small wedges.
2 spring blocks.
1 gudgeon block.
1 treadle.
2 iron springs.
6 target frames (3 pairs).
4 ½-inch wide wooden pins.
1 top support with 2 turned pins.

A horizontal axis target complete consists of the following parts. These parts are the same for both sizes of targets, except that some of their dimensions differ, and requisitions should state for which size they are required:

Parts of a horizontal axis target.

1 axis.
2 levers.
2 nave boxes.
1 center or lever block.
2 journal boxes.
2 journal posts with 4 turned pins.
1 treadle and stake.
2 spring blocks.
2 iron springs.
1 pulley.
4 large wedges.
2 small wedges.
4 ½-inch wooden pins.
6 target frames (3 pairs).

Sliding Targets.

There are two sizes of these targets, viz, 6 by 6 feet and 6 by 12 feet. Each target complete consists of—

1 timber frame support.
2 carriages.
6 target frames.

The following lists of parts contain all the spare parts which can require renewal, and for which requisitions should be made under the head of spare parts, except for parts of target frames. (See parts of target frames on pages 986 and 987, under the head of "Parts of target frames.")

The list of parts is the same for both sizes of targets, but as the dimensions of some parts are different for the two sizes, requisitions for parts should specify for which size targets they are required.

List of parts for one timber frame support.

Wood.

1 main sill.
1 top beam.
2 cross sills.
2 posts.
2 braces.

Metal.

2 stay rods.
4 eye bolts.
4 slide rods.
2 top plates for slide rods.
2 bottom plates for slide rods.
8 bolts, 5½ inches long.
8 bolts, 6½ inches long.
2 pulleys and fittings.
4 sash-cord clamps.
2 fastening hooks.
2 pieces sash cord, 12 feet long.

List of parts for two carriages.

8 slide irons and bolts.
2 wooden carriage frames.

NOTE.—Parts for repairing the wooden carriage frames are not furnished. These frames can be repaired with lumber on hand at posts, or requisitions for lumber can be made. Broken or condemned carriages should be preserved, and the good parts of the same used in repairing other carriages. Lists of the parts of the target frames are given on pages 986 and 987, under the head of "Parts of target frames."

ROLLING TARGET.

One target complete consists of—

1 car.
2 pieces of track.
6 target frames, 6 by 12 feet.

One car and two pieces of track furnish a double target for paper targets A, and a single target for paper targets B and C. One paper target A is mounted at each end of the target frame and exposed alternately at each end of the butt. Only one paper target, B or C, can be mounted on the target frame.

To convert the target into a double target for paper targets B and C, add one car and one piece of track.

List of parts.

One car.

1 wood frame.*
4 truck wheels (iron).
2 axles.
4 half boxes.
4 hook bolts.
1 pole.
1 piece rope, 12 feet long.

One piece of track.

1 wood frame (with iron tie-rods).*
2 iron rails.
4 fish plates.
8 fish-plate bolts.
20 spikes.

PARTS OF TARGET FRAMES.

Target frames for revolving targets (Laidley).

(The same target frame is used on both the horizontal and vertical axis, 6 by 6 feet target.)

List of parts.

For a 6 by 6 foot horizontal and vertical axis target, one target frame consists of—

2 side rails.
1 outer rail.
1 inner rail.
4 wedges.

For a 6 by 12 foot horizontal axis target, one frame consists of—

2 side rails.
1 outer rail.
1 inner rail.
2 braces, corner.
4 wedges.
4 pins.

For a 6 by 12 foot vertical axis target, one frame consists of—

2 side rails.
1 outer rail.
I inner rail.
1 brace, diagonal.
4 wedges.
2 pins.

* The remark in regard to the wood frames for the carriages for the sliding targets applies also to these frames

Target frames for sliding targets.

There are two sizes of these frames, viz, for 6 by 6 foot targets and for 6 by 12 foot targets. Paper targets A and B are used on the 6 by 6 foot frames and paper target C on the 6 by 12 foot frames.

List of parts.

6 by 6 foot target frame.
2 vertical rails.
2 horizontal rails.
4 wedges.

6 by 12 foot target frame.
2 vertical rails.
2 horizontal rails.
4 corner braces.
4 wedges.
8 pins.

Target frames for rolling targets.

There is but one size of these frames, viz, 6 by 12 foot. Two paper targets, A or B, are mounted on the same frame at each end and exposed alternately at each end of the butt, and one paper, target C, is mounted on this frame.

List of parts.

2 vertical rails.
2 horizontal rails.
4 corner braces.
2 rear braces.
4 wedges.
8 pins.
4 pins, turned.

GENERAL REMARKS.

As has been stated, a rolling target, complete, which consists of one car and two pieces of track (and target frames), can be converted into a double target for paper targets B and C by adding one car and one piece of track.

Should it ever be necessary or desirable for economy to convert a 6 by 6 foot target into a 6 by 12 foot target, or *vice versa*, of the revolving patterns, an officer having a target on hand could readily see from the foregoing lists of parts what parts must be changed, and make requisition accordingly. For instance, in the sliding target, the only parts to be changed are the wooden frames for the carriages and the top beam and main sill.

Parts of target frames which are identical in different patterns and sizes of targets, and which are therefore interchangeable.

In the sliding target frame the vertical rails are the same in both the 6 by 6 foot and the 6 by 12 foot target frames. Moreover, by cutting off 24 inches at the bottom of these rails, they can be adapted to and used on the rolling target.

All the parts of a 6 by 12 foot target frame for the sliding and rolling targets are identical, except the length of the vertical rails mentioned above.

None of the parts of target frames for revolving (Laidley) targets can be used in the other two patterns of targets.

A complete outfit of wedges and pins is issued with each complete target frame, but as these are not often injured by firing they are not issued with parts of target frames for repairs.

Very respectfully, your obedient servant,

D. W. FLAGLER,
Lieutenant-Colonel, Ord. Dept., Commanding.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

ROCK ISLAND ARSENAL, ILL., *May 11, 1886.*

SIR: Referring to a report sent you to-day on targets and parts of the same, now in use in the Army, I have the honor to ask attention to the names now in use for the sliding and rolling targets. The names Brinton and Cushing are still used for these targets.

So far as the sliding target now in use is concerned, it possesses nothing which pertained to the Brinton except the principle of counterbalancing two targets and sliding them alternately up and down to expose them above a butt. This principle was not new, I believe, in the Brinton, as I see it in use at German Schuetzen parks, where it was in use prior to any knowledge of the Brinton in our service.

The method of applying the principle in the Brinton was to attach gas pipe or rods to the butt and slide the target frames themselves up and down these rods. In the new sliding target, a new movable timber frame support has been devised on which to mount the target. On this are mounted two carriages which are counterbalanced and slide up and down. So much of the target is permanent and not exposed to fire, and it is all movable and can be set up in any pit and behind any butt. New pattern target frames are then mounted on these carriages and these being exposed to fire are detachable and can be renewed.

I am not familiar with the history of the Brinton target, but if, as I believe, it was simply a method of applying an old principle, then the new target is an entirely new method of applying the same principle and is a new sliding target.

The Cushing target was the movable target described on page 144 (Laidley Rifle Firing), for which Capt. Cushing devised a truck and track.

The rolling target now in use is also a movable target, but in devising a suitable car track and other appliances therefor I made no use of the Cushing target. As they are both movable targets, composed of car and tracks, they are similar, but no more so than two gun carriages or saddles of different patterns.

Throughout the inclosed report I have used for the three systems of targets the alternative names of revolving, sliding, and rolling for Laidley, Brinton, and Cushing, as describing the system or principle of the three targets, in case you should desire to adopt these names instead of those now in use.

For the reasons given above, I think the names Brinton and Cushing incorrect.

Very respectfully, your obedient servant,

D. W. FLAGLER,
Lieutenant-Colonel, Ord. Dept., Commanding.

The CHIEF OF ORDNANCE, U. S. ARMY,
Washington, D. C.

(2093–'86.)

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